



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : A61C 8/00		A2	(11) International Publication Number: WO 99/17676	
			(43) International Publication Date: 15 April 1999 (15.04.99)	
(21) International Application Number: PCT/US98/21031			(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).	
(22) International Filing Date: 2 October 1998 (02.10.98)				
(30) Priority Data: 60/060,801 3 October 1997 (03.10.97) US 60/061,076 3 October 1997 (03.10.97) US 60/074,404 11 February 1998 (11.02.98) US				
(71) Applicant: IMPLANT INNOVATIONS, INC. [US/US]; 4555 Riverside Drive, Palm Beach Gardens, FL 33410 (US).				
(72) Inventors: ROGERS, Dan, Paul; 10102 Yeoman Lane, Royal Palm Beach, FL 33411 (US). BROWN, Gale, R.; 4461 S.W. Bimini Circle North, Palm City, FL 34990 (US). GOODMAN, Ralph, B.; 4965 Summit Boulevard, West Palm Beach, FL 33415 (US). LAZZARA, Richard, J.; 1814 North "R" Street, Lake Worth, FL 33460 (US). PORTER, Stephen, S.; 178 Bent Tree Drive, Palm Beach Gardens, FL 33418 (US).				
(74) Agent: RUDISILL, Stephen, G.; Arnold, White & Durkee, P.O. Box 4433, Houston, TX 77210 (US).				
(54) Title: SINGLE-STAGE IMPLANT SYSTEM				
(57) Abstract				
<p>A single stage dental implant for implantation in living jawbone having overlying gingiva comprises a generally cylindrical body section having an exterior surface for confronting the jawbone and a head section attached to the body section for extending through the overlying gingiva when the body section is confronting the jawbone. The head section has an end portion which is generally near an outer layer of the gingiva. The implant further includes a bore within the head section extending to an opening at the end portion of the head section. The bore is defined by first, second, and third walls. The first wall has internal threads. The second wall has a larger diameter than the first surface and is substantially cylindrical. The second wall extends from the first wall toward the end portion. The third wall extends from the second wall to the opening and flares toward the opening to a diameter that is wider than a diameter of the second wall. The implant is delivered to the site in the patient's mouth with a carrier that is expanded into the second wall of the bore thereby developing a tight engagement capable of withstanding the insertion torque. The implant can be fitted with posts which extend above the upper portion of the implant. The post can be fitted with gingival forming components and temporary posts.</p>				

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	MW	Malawi	TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon	KR	Republic of Korea	PL	Poland		
CN	China	KZ	Kazakhstan	PT	Portugal		
CU	Cuba	LC	Saint Lucia	RO	Romania		
CZ	Czech Republic	LI	Liechtenstein	RU	Russian Federation		
DE	Germany	LK	Sri Lanka	SD	Sudan		
DK	Denmark	LR	Liberia	SE	Sweden		
EE	Estonia			SG	Singapore		

SINGLE-STAGE IMPLANT SYSTEM

FIELD OF THE INVENTION

The invention relates generally to implants and, in particular, a single-stage dental implant that promotes healing of the gingiva and osseointegration simultaneously.

BACKGROUND OF THE INVENTION

- 5 It is becoming more common to replace a missing tooth with a prosthetic tooth that is placed upon and attached to a dental implant. The dental implant serves as the artificial root in that it integrates with the jawbone. The prosthetic tooth preferably has a size and a color that mimics the missing natural tooth. Consequently, the patient has an aesthetically pleasing and structurally sound artificial tooth.
- 10 Current methods by which the prosthetic tooth and implant are completely integrated into the patient's mouth require six to ten months, and sometimes longer, because two distinct, time-consuming steps are involved. First, the implant is inserted into the jawbone and covered by suturing the overlying gingival tissue. Covering the implant with the overlying gingiva is needed to minimize the likelihood of infection around the implant.
- 15 Covering the implant also helps to guard against any disturbances of the implant that may slow its rate of osseointegration. The implant then osseointegrates with the jawbone for a period, usually in the range of three to six months.

After osseointegration is complete, the second step is encountered in which the gingiva is again cut open and a healing abutment is placed onto the implant. The overlying gingiva is sutured to allow it to properly heal around the healing abutment. Thus, when the prosthetic tooth is eventually placed upon the implant, the gingiva nicely conforms around the prosthetic tooth. However, it typically takes four to eight weeks before the gingiva is healed and the prosthetic tooth can be placed on the implant to complete the overall process. These implants can be referred to as "subgingival implants."

- 25 Single-stage implants or "transgingival implants" simultaneously promote osseointegration and the healing of the gingiva. This is accomplished by providing an implant that has a portion that integrates with the jawbone and a portion that extends through the overlying gingiva so that the gingiva properly heals therearound. Thus, the four to eight week gingival healing process occurs during the three to six month period of osseointegration. Consequently, the patient is fitted with a prosthesis in a shorter period of
- 30

time. And, the gingiva is lacerated and sutured one less time compared with two-stage systems which reduces the trauma to that region, the discomfort experienced by the patient, and the overall cost because the number of dental procedures is minimized.

It is sometimes desirable to convert a subgingival implant to the configuration of

5 a transgingival style or vice versa. For example, if one style is best suited for installation in a first site in a patient's jawbone, but another style is best suited for installation in another site, the restoring dentist seeking to fashion a bridge supported on implants installed in both sites might prefer to convert one style to the other in order to make the bridge using common components. Similarly, if a restoring dentist has on hand implants

10 of one style and components for a new improved style become available, for reasons of economy it might be desirable to convert the available implants to the new styles so they can be used with the new components. However, known transition components introduce gaps between the components and present alignment problems for the restoration components.

15 Furthermore, during the preparation of dental restorations supported on artificial roots implanted in living jawbone, it is frequently useful to provide a temporary cover for a post or abutment (that eventually holds the artificial dentition) supported on a transgingival implant. It is also desirable to prevent the gingival tissue from collapsing around the transgingival implant or to maintain an opening in the tissue at least until

20 temporary dentition is made. This invention also relates to a temporary cap useful to cover such abutments and posts for a transgingival implant.

SUMMARY OF THE INVENTION

The single-stage dental implant is typically installed through a ridge in the jawbone that is covered by gingival tissue. The dental implant provides an artificial root on which a prosthetic tooth is mounted to replace a missing tooth which formerly emerged from the

25 jawbone. The single-stage implant comprises an anchoring portion for extending into and integrating with the jawbone and an integral gingival section that extends beyond the ridge of the jawbone. Because the gingival section is integral with the anchoring portion, there is no seam in which bacteria may collect to cause infections.

The implant has various embodiments with various internal structures which allow

30 the implant to be driven into the bone tissue in the patient's mouth. These internal

structures typically engage a carrier that is delivered with the implant. Thus, the clinician uses tools that engage the carrier to drive the implant to the appropriate depth. After insertion, the clinician removes the carrier from the implant and a cover screw is placed thereover. The implant also has structural features enhancing its ability to support the 5 artificial dentition on the post.

The inventive single-stage system also includes conversion components that allow a subgingival implant to have the same contour and structure as a transgingival implant. To convert a subgingival implant, a tubular member having an outer contour the same as the gingival head section of the transgingival implant is non-rotationally 10 attached to the hexagonal fitting on the upper end of the subgingival implant. The fastener holding the tubular member on the implant extends above the tubular component and usually contains a non-rotational fitting (e.g. a hexagon). To convert the transgingival implant, a single transition component is threaded into the bore of the transgingival implant. The upper part of the transition component has the same contour 15 as the portion of the fastener (used with the tubular member) extending above the tubular member. Thus, these conversion components provide a precise configuration that is present on both a converted transgingival implant and a converted subgingival implant which allows both to use the same restoration components.

The inventive single-stage implant system further contemplates novel 20 components to mate with the posts of the implants. The posts and abutments (hereinafter "posts" for convenience) on which artificial teeth are mounted generally extend supragingivally from a base at or beneath the gum surface to an end that may be narrower than the base. One inventive cap is hollow and open at least at its lower end so as to envelop the post in a generally telescopic manner when placed over the post. The 25 end of the cap facing the base of the post is fitted with a rim enclosing an annular hollow space so as to snap over the periphery of the base when the cap encloses the post. When so fitted over the post, the cap covers the post and prevents the gum tissue from collapsing around the base of the post and top of the implant. It may also maintain an opening through the gum tissue for use by the restored tooth that is eventually mounted 30 on the post. If it is desired for the cap to function as a temporary tooth, a suitable

temporary cement can be used to fill the space between the cap and the post, in which event the hole in the top of the cap will serve as a vent for excess cement.

In another embodiment of the invention, the cap is open at its top and has perforations through its sides. When this embodiment is fitted over the post and covered 5 with a tooth-shaped shell filled with a suitable dental plastic material that can be forced through the perforations into contact with the post and allowed to harden in a short time, a temporary tooth in the shape of the shell can be fashioned at chairside in the mouth of a patient, or on a model of the patient's case out of the patient's mouth. When the plastic material hardens, the shell can be removed, and this tooth can be cemented to the post to 10 function as a temporary tooth which is cosmetically similar to adjacent teeth.

The above summary of the present invention is not intended to represent each embodiment, or every aspect, of the present invention. This is the purpose of the figures and the detailed description which follow.

BRIEF DESCRIPTION OF THE DRAWINGS

15 In the accompanying drawings:

FIGS. 1a-1c are side, insertion end, and gingival end views of an implant according to the present invention;

FIGS. 2a-2c are side, insertion end, and gingival end views of an implant;

FIGS. 3 and 4 are side views of an implant with a roughened outer surface;

20 FIGS. 5a-5c are side, insertion end, and gingival end views of a wide-diameter implant;

FIGS. 6a-6d are side, section, head end, and insertion end views of a cover screw;

FIGS. 7a-7d are side, section, head end, and insertion end views of a cover screw;

FIGS. 8a-8c are side, head-end, and insertion-end views of a cover screw;

25 FIGS. 9a-9d are a side view, supragingival end view, insertion end view, and an assembly view of an abutment post for supporting a dental prosthesis;

FIGS. 10 is a side view of a gingival end of an implant with a carrier attached thereto;

FIGS. 11a-11c are side, insertion end, and gingival end views of an implant;

30 FIGS. 12 is an enlarged view of the gingival end of FIG. 11;

FIGS. 13a-13c are side, longitudinal section, and top end views of a mount body;

FIGS. 14a-14b are a mount screw and a head-end view for use with the mount body of FIG. 13;

FIG. 15 is an exploded side elevation, partially in section, view of a transition component and associated components for use with a transgingival-style dental implant;

5 FIG. 16 shows the components of FIG. 15 assembled;

FIG. 17 is an exploded side elevation, partially in section, of a transition component and associated components for use with a subgingival-style implant;

FIG. 18 shows the components of FIG. 17 assembled.

FIG. 19 is a longitudinal section taken through the middle of a cap embodying the 10 invention;

FIG. 20 is a bottom plan view of the cap of FIG. 19;

FIG. 21 is an enlarged view of the lower right-hand corner of the cap of FIG. 19;

FIGS. 22a-22c are a side elevation, a top perspective, and a bottom perspective view of a modified cap embodying the invention;

15 FIGS. 23a-23c are a vertical section, a top perspective, and a bottom perspective view taken through the middle of the cap of FIG. 22;

FIG. 24 is a side elevation, partially in section, of an implant system using the cap of FIGS. 22 and 23; and

FIG. 25 is the same sectional view of the cap as in FIG. 23 with the addition of a 20 diagrammatic illustration of an artificial tooth shell around the cap.

DETAILED DESCRIPTION OF THE DRAWINGS

FIGS. 1a-1c illustrate an implant 10 having a main body 12 with a threaded outer surface 13. The threaded outer surface 13 includes a self-tapping region with incremental cutting edges 14 at an apical end 16 of the main body 12. These incremental cutting edges 14 are defined in detail in U.S. Patent No. 5,727,943, entitled "Self-

25 Tapping, Screw-Type Dental Implant" which is herein incorporated by reference in its entirety.

An axial opening 18 in a gingival end 20 of the main body 12 has three distinct zones proceeding from the uppermost edge of the gingival end 20 into the interior of the implant 10. An inwardly-tapering zone 22 is followed by a substantially cylindrical zone

30 24 which, in turn, is followed by an internally-threaded zone 26.

An outer surface 28 tapers downwardly from the uppermost edge of the gingival end 20 to a maximum diameter region 30. On the outer surface 28 between the uppermost edge of the implant 10 and the maximum diameter region 30 is a set of flat surfaces 32 shown here in a commonly-used hexagonal configuration. This set of flat surfaces 32 can be engageable with a tool that screws the implant 10 into the bone tissue. Alternatively, the set of flat surfaces 32 may be engaged by a carrier that is delivered with the implant 10 such that the clinician applies torque to the carrier which then is transferred into the implant 10 (see FIG. 10). The distance 34 between two parallel flat surfaces 32 can be made larger than the major diameter of the threads defining the threaded outer surface 13 of the main body 12 of the implant 10.

With regard to the details of the structure in the gingival end 20, each of the three zones 22, 24 and 26 of the opening 18 has a unique function. Each function is useful in connection with several different components of the system. These components will be discussed with reference to FIGS. 6-10.

FIGS. 2a-2c disclose an implant 36 that differs from the implant 10 of FIG. 1 in the details of cutting edges 14' and the contours of the threads defining the threaded outer surface 13'. When viewed in cross-section, the threaded outer surface 13' is non-circular in the region of the threads and/or the troughs between the threads. This type of thread structure is defined in detail in U.S. Application Serial No. 08/782,056, filed January 13, 1997, entitled "Reduced Friction, Screw-Type Dental Implant" which is herein incorporated by reference in its entirety. However, the zones 22, 24, and 26 of the opening 18 and the structure at the gingival end 20 are the same in the implant 36 as the implant 10 of FIGS. 1a-1c.

In FIG. 3, an implant 38 has a roughened outer threaded surface 40. The roughened outer threaded surface 40 may be produced through grit blasting or acid etching, or a combination of these two procedures. Exemplary processes of grit blasting and acid etching are described in U.S. Patent Nos. 5,607,480 and 5,603,338 which are herein incorporated by reference in their entirety. The roughened outer threaded surface 40 enhances the osseointegration process. However, the gingival end 20 has a smooth outer surface such that it will not irritate the soft gingival tissue that contacts the gingival end 20.

In FIG. 4, the implant 38 of FIG. 3 is illustrated having a roughened outer threaded surface 40 that extends into the gingival end 20. Thus, a transition line 39 between the roughened outer threaded surface 40 and the smooth surface at the gingival end 20 is located within the second zone 24. The positioning of the transition line 39 closer to the gingival end 20 may be useful in situations where more of the gingival end 20 is inserted into the bone.

In FIGS. 5a-5c, an implant 41 having a wide diameter in the region of its roughed outer threaded surface 42 is illustrated. The diameter is in the range from about 4.5 mm to about 6.0 mm with the diameter of 5.0 mm being a fairly common dimension for a wide diameter implant. Such an implant 41 is useful to engage one or both cortical bones to provide enhanced stability, especially during the period of time after installation. The gingival end 20 again is structurally the same as the implants of FIGS. 1-4.

Several types of components are attachable to the implants of FIGS. 1-5. FIGS. 6-8 illustrate various types of cover screw that are inserted into the implant 10. Referring initially to FIGS. 6a-6d, a cover screw 44 has a head 46, an externally-threaded insertion end 48, and a cylindrical shaft 50 between the head 46 and the insertion end 48.

In use, the insertion end 48 of the cover screw 44 is threaded into the internally-threaded zone 26 of the opening 18 of the implant 10. The cylindrical shaft 50 fits within the cylindrical zone 24 of the opening 18 of the implants in FIGS 1-5. The mating of the cylindrical zone 24 and cylindrical shaft 50 provide stability during insertion of the cover screw 44 into the opening 18. The head 46 has a reentrant under-surface 52 which covers the outer surface 28 and the flat surfaces 32 of the implant when the cover screw 44 is placed on the implant of FIGS. 1-5. The head 46 also has a bore 54 with flat surfaces 56 for engaging a tool, such as an Allen wrench, that turns the cover screw 44 into the internally-threaded zone 26 of the implant.

FIGS. 7a-7d illustrates a cover screw 60 having a head 62, a threaded insertion end 64, and cylindrical shaft 66 between the head 62 and the insertion end 64. The threaded insertion end 64 threadably engages the internally threaded zone 26 of the implants of FIGS. 1-5. The cylindrical shaft 66 resides within the cylindrical zone 24. The head 62 includes an undercut 67 that covers the outer surface 28 and the flat surfaces 32 of the implant. The head 62 also has a bore 68 with a region for engaging a tool that

installs the cover screw 60 into the implant. The primary difference between the cover screw 60 and the cover screw 44 of FIG. 6 is that the head 62 of the cover screw 60 has an increased height such that it would extend further above the gingiva.

In FIGS. 8a-8c, a cover screw 70 has a head 72 with a tapering side-surface 74 for 5 engaging the tapered zone 22 of the opening 18 of the implants of FIGS. 1-5. The upper surface of the head 72 would be approximately flush with the uppermost edge of the gingival end 20 of the implants. The tapering surfaces of the tapered zone 22 and the side-surface 74 are preferably tapered on the same angle suitably to provide a locking taper (e.g. about 18°) when those surfaces are engaged. A cylindrical shaft 78 is placed 10 between the head 72 and a threaded insertion end 79.

The head 72 has a bore 76 with flat surfaces for engaging a wrench that turns the cover screw into the internally-threaded zone 26 of the opening 18. The cover screw 70 of FIG. 8 may be especially suitable for use with wide-diameter implants (e.g. FIG. 5), where the cover screw design of FIGS. 6 and 7 might be excessively bulky.

15 In FIGS. 9a-9d, an abutment post 80 includes four zones in a longitudinal sequence, namely, a supragingival zone 82, a locking-taper zone 84, a substantially cylindrical zone 86, and an externally-threaded zone 88. The last-mentioned three zones 84, 86 and 88 correspond, respectively, to the zones denominated 74, 78 and 79 in the cover screw 70 of FIG. 8. In use, the abutment post 80 is attached to one of the implants 20 of FIGS. 1-5 by inserting the externally-threaded zone 88 into the internally-threaded zone 26 of the opening 18 and rotating the post 80 until the tapered zones 84 and 22 engage and lock together. During the process of turning the post 80 into the implant, the cylindrical zones 24 and 86 provide axial stability that prohibits cross-threading the threaded surfaces of zones 88 and 26. The axial stability provides for true engagement of 25 the tapering surfaces 84 and 22. The supragingival zone 82 has longitudinally-extending grooves 89 that are useful for engaging a tool to turn the post 80 into the implant. These grooves 84 are also helpful to hold a cemented prosthesis against rotation on the post 80.

To ensure that the tapering surfaces 84 and 22 do not resist in providing the required axial tension strain from the engagement of the threaded portions 88 and 26, the 30 tapering surfaces 84 and 22 may be provided with a lubricant to reduce the friction between them. Biocompatible lubricants may be provided. Alternatively, the plating of

one of the tapered surfaces, preferably the tapered surface 84 of the post 80, with gold may provide the necessary friction-reducing means. This type of friction-reducing plating is described in U.S. Provisional Application Serial Nos. 60/059,307 and 60/043,106, filed September 17, 1997 and April 17, 1997, respectively, and entitled

5 "Dental Implant System having Improved Stability" and "Low Insertion Torque Screws for Use With Dental Implants", respectively, which are herein incorporated by reference in their entirety. Thus, the locking tapers may be lubricated through traditional biocompatible lubricants or metallic molecules which serves as a solid type of lubricant.

As shown in FIG. 9d, when the post 80 is assembled on an implant, such as 10 implant 41 of FIG. 5, the flat surfaces 32 are outside the post 80. Thus, the flat surfaces 32 also serve the function of engaging a prosthesis against rotation on the implant, independent of any engagement between the prosthesis and the post 80.

As an alternative post configuration, the post may be made of two pieces, a 15 tubular member to mate with the outer surface 28 and a threaded post that is inserted through the tubular member and holds the tubular member on the implant. Such a two-piece abutment system is disclosed in U.S. Serial No. 08/729,869, filed October 15, 1996, entitled "Two-Piece Dental Abutment," which is herein incorporated by reference in its entirety.

In FIG. 10, a carrier for the implants of FIGS. 1-5 includes a main body 90 that 20 has a structure 92 for engaging a driving tool that provides torque to the combination of the carrier and the implant. Although that structure 92 is illustrated on the exterior surfaces of the main body 90, that structure may be located on the interior surface of the main body 90 as well. The main body 90 includes an extending portion 94 that has at its lowermost portion a diameter that is narrow enough to be inserted into the cylindrical 25 zone 24 of the gingival end 20 of the implant.

The main body 90 includes an overlapping region with an internal surface 95 that fits over the flat surfaces 32 of the gingival end 20. The internal surface 95 has the cross-sectional shape of a hexagon to mate with the hexagonal shape of the flat surfaces 32.

Between the overlapping region and the extending portion 94 is a tapered region 30 96 that fits the tapered zone 22 of the gingival end 20. However, the tapered region 96 does not need to engage the tapered zone 22. Although not shown, the extending portion

94 and the shank region 96 have an axially extending slot whose function is described below.

The extending portion 94 and shank portion have internal threads 97 that mate with screw 98 that is inserted into the bore of the main body 90. When the screw 98 is 5 inserted into the internal threads 97, the extending portion 94 expands outwardly so as to become in tight frictional engagement with the cylindrical zone 24 of the implant. This process of affixing the carrier onto the implant is typically performed at the manufacturer's facility such that the carrier and the implant are delivered to the clinician as one unit. When the clinician uses the combination of the carrier and the implant, he or 10 she places the apical end 16 of the implant 10 (see e.g. FIG. 1) into a bore in the jawbone. The clinician then uses a tool that engages the structure 92 on the main body 90, to turn the implant (with its self-tapping threads) into the bore. When the implant is inserted to the proper depth, the clinician then engages the non-circular bore 99 of the screw 98 with a tool and removes it from the implant. To ensure that the torque applied 15 to the screw 98 during its removal does not rotate the entire implant, the direction of the thread of the screw 98 is chosen such that the applied torque would cause the implant to be further inserted into the bone. However, since the insertion of the implant would require more torque than the torque necessary to remove the screw 98, the implant remains motionless while the screw 98 is removed.

20 The implant 110 of FIGS. 11a-11c differ from implants of FIG. 1-5 in that the implant 110 has a cylindrical zone 124 that is fitted with shallow helical grooves 125 in the surface of the wall defining the cylindrical zone 124. Thus, a portion of this wall defining the cylindrical zone 124 remains intact as it forms the lands between adjacent grooves 125. Furthermore, the implant 110 lacks the flat surfaces on its outer surface 25 that form the hexagon on the gingival end as is shown in the implants of FIGS. 1-5. In other words, the outer surface 128 of the implant 110 is smooth. However, the remaining structures of implant 110 are the same as implant 10 of FIG. 1 and, thus, those remaining structures are now denoted by a 100-Series reference numeral.

Referring now to FIG. 12, the cylindrical zone 124 of the opening 118 is shown 30 in detail. Four grooves 125 form a multi-lead thread having a relatively large pitch. The grooves 125 do not cut deeply into the cylinder wall so that they leave relatively wide

lands 127 between adjacent grooves 125 thereby preserving the portion of the cylinder wall intact. In one practical embodiment of the implant 110, the axial length of the cylindrical zone 124 is a little more than 1 mm and the pitch of the threads formed by the grooves 125 about 1 mm. Thus, a single turn of a screw threadably mating with the

5 grooves 125 serves to insert or remove that screw from the zone 124.

Even with the structure of the cylindrical zone 124 of FIGS. 11-12, the implant 110 can cooperate with the covers screws of FIGS. 6-8, and with the abutment post 80 of FIG. 9. Additionally, it serves functions related to the purposes of the implant mount and screw shown in FIGS. 13 and 14.

10 The implant mount 170, or carrier, shown in FIGS. 13a-13c has a head section 172 of non-round (here hexagonal) cross-section suitable for engaging with a socket wrench. The mount 170 has a through passage 174 extending from the head section 172 through a tail end 176. The through passage 174 has internal threads 178 in the head section 172. The tail end 176 has external threads 180 suitable for engaging the grooves 15 125 of the multi-lead thread in the cylinder zone 124 of the implant 110 of FIGS. 10-11. Longitudinally-directed slots 182 in the tail end 176 extend toward the head section 172. As seen best in FIG. 13C, four slots 182 are used in the illustrated embodiment, forming four fingers 183 in the tail-end 176. These slots 182 may all be the same length, or they may have different lengths. In one embodiment, one pair of opposing slots are longer 20 than the intervening pair. Immediately inside the tail end 176, the passage 174 is partially obstructed with wedge blocks 184, one of which is attached to each finger 183.

Between its ends, the mount 170 has a radially-extending flange 185 similar to the head 46 of the cover screws of FIG. 6 & 7. The flange 185 includes a reentrant under-surface 187 that engages the outer surface 128 of the gingival end 120.

25 The mount screw 190 of FIG. 14 has an externally-threaded section 192 between its head end 194 and its tail end 196. A cylindrical shaft 198 extends between the threaded section 192 and the tail end 196 suitably dimensioned for fitting within the passage 174 of the implant mount 170. At the tail end 196, the shaft 198 has a tapered end-section 197 for engaging between the wedge blocks 184 of the implant mount 170.

30 In its head end 194, the screw 190 has a non-round (here shown as hexagonal) socket 200 for engaging a wrench, such as an Allen wrench.

In use, the implant mount 170 of FIG. 13 is inserted through the implant passage 118 and threaded via the threads 180 at its tail end 176 into the threaded cylindrical zone 124 of the implant 110. In a preferred embodiment, approximately one turn is required to seat the flange 185 of the implant mount 170 over the outer surface 128 of the implant 5 110 using a torque of about 10 N-cm. The mount screw 190 is then inserted through the passage 174 of the implant mount 170 and its threaded section 192 is engaged in the internal threads 178 in the head section 172 of the mount 170. A suitable wrench engaged in the socket 200 is useful to drive the mount screw 170 into and between the wedge blocks 184 and thereby apply a radially-directed force to spread the tail end 176 10 within the cylindrical zone 124 using a torque of about 15 N-cm.

The implant 110 of FIG. 11 with the implant mount 170 and screw 190 (FIGS. 13 and 14) installed as herein described are carried to the site in the mouth of the patient. The implant 110 is installed in the prepared site with a torque required to overcome the cutting of the bone at the self-tapping region. Such torque is generally less than about 40 15 N-cm. Tests applying torque forces in excess of 100 N-cm have shown that the fingers 184 may be expected to break when the torque exceeds about 120 N-cm which is a far greater torque than would be encountered in a real-life situation.

After the implant 110 has been installed in the patient's bone, the mount 170 is easily removed by loosening the screw 190 and turning the mount 170 in reverse by 20 approximately one turn to release it from the implant 110. The invention also contemplates an embodiment where the screw 190 is held captive in the passage 174 of the mount 170 such that both pieces remain together during their removal from the implant.

With regard to the conversion between subgingival and transgingival implants, it 25 is highly desirable for successful dental restoration that the components of a restoration system be precisely dimensioned and that dimensional precision be maintained at every stage in the process of constructing the restoration. For example, implants of the subgingival style are commonly fitted at their occlusal ends with an anti-rotational connecting element for coupling a transgingival component to the implant in a manner 30 that prevents the component from rotating on the implant, around the axis of the implant. These anti-rotational connection elements usually take a hexagonal form, although

octagonal forms are also in use. Because of manufacturing tolerance limitations, it is difficult to make hexagonal (for example) posts and sockets that will fit together so tightly that they will not allow some little amount of relative rotation between the connected implant and component. The degree of tightness required to eliminate all 5 relative rotation would make connecting and disconnecting these two parts in the mouth of a patient so difficult that the patient would be unacceptably uncomfortable. A solution to this problem is described in the assignee's copending U.S. patent application Serial No. 08/451,083, filed May 25, 1995, for "Anti-rotational Connecting Mechanism," now U.S. Patent No. 5,725,375.

10. Experience has shown that available transition components tend to leave a small gap extending part-way around the periphery of the implant surface. This is believed to be due, at least in part, to the difficulty of accurately attaching restoration components to the transition component. This in turn makes it difficult to achieve and maintain precise axial alignment of the implant, the transition component and the restoration component. 15. Accordingly, in addition to the inventive transgingival style of implant, the present invention addresses the alignment, tolerance, and gap problems as will be shown in FIGS. 15 and 16.

FIGS. 15 and 16 relate to conversion components for converting between a subgingival and transgingival implant. A transition component 240 has a lower section 20 designed to fit into the implant 110 of FIGS. 11-12. This lower section includes a tapered zone 242, an intermediate zone 244 and an externally threaded zone 246 designed to fit in the corresponding zones 122, 124, and 126 of the implant bore 118. Specifically, the threaded zone 246 screws into the innermost zone 126 of the implant, the intermediate zone 244 mates with the intermediate zone 124 of the bore 118, and the 25 tapered zone 242 seats in the outermost zone 122 of the implant bore 118. A locking taper is formed by the engaging side walls of the zones 122 and 242, and thus only a short thread section 246 is needed on the distal end of the transition component.

The transition component 240 also has an upper section that extends beyond the occlusal end of the implant. This upper section includes a hexagonal anti-rotation zone 30 250 and a locator zone 252, extending in sequence supragingivally from the implant when the transition component 240 is installed in the bore 118. The axial length of the

locator zone 252 is preferably larger than the axial length of the anti-rotation zone 250.

The locator zone 252 is preferably round in cross-section, and smaller in cross-sectional size than, the anti-rotation zone 250.

A hollow abutment 260, which performs the function of a non-rotating cylinder 5 used to support an artificial tooth, fits over the upper section of the transition component 240 and the occlusal surface of the implant 110. The inside surface of the abutment 260 includes an upper section 262 and a lower section 264 separated by a flange 266. The upper section 262 receives the head of a retainer screw 267, with the screw head resting on the shoulder formed by the upper surface of the flange 266. The lower section 264 10 includes a locator zone 268 above the usual hexagonal socket 270, and a flared skirt 272 extends outwardly and downwardly from the bottom edge of the socket 270 to the bottom periphery of the abutment. The inside surface of the skirt 270 preferably flares on an angle (measured from the longitudinal axis through the implant and attached components) that is a little smaller than the slope angle of the outer surface 128 of the 15 implant 110, so that the initial contact between these two surfaces occurs at the bottom edge of the skirt 272.

When the abutment 260 is fitted to the transition component 240, the locator zone 268 of the abutment makes first contact with the locator zone 252 and serves to align the abutment axially with the transition component. Because the two mating locator zones 20 252 and 268 are both cylindrical and very close to the same size, the abutment 260 can be turned around the common axis until the anti-rotation zones 250 and 270 are in register. The abutment 260 can then be seated accurately on the transition component 240, and the retainer screw 267 can be screwed into the bore 254 and tightened to seat the skirt 272 on the outer surface 128 of the implant 110.

25 Because the mating locator zones 268 and 272 guide and align the abutment 260 as it is fitted over the transition component 240, the abutment 260 is accurately seated on both the transition component 240 and the outer surface 128 of the implant 110, thereby avoiding any microgaps at the interface between the abutment and the implant. As described above, precise alignment is further facilitated by the fact that the outer 30 periphery of the skirt 272 makes first contact with the outer surface 128 of the implant 110, and further tightening of the screw 267 increases the annular area of that contact.

15

The tube 280 shown in FIGS. 15 and 16 is a known component used to make an artificial tooth using the lost-wax process. The tube 280, which is typically made of a material that is burned away in the course of the lost-wax process, fits over the abutment 260 down to the skirt 272. A waxing sleeve 282 is provided to cover the skirt.

5 The invention can be adapted to modification of a subgingival-style implant 284, as is shown in FIGS. 17 and 18, where parts common with FIGS. 15 and 16 bear the same reference characters. The subgingival-type dental implant 284 is indicated in part under an abutment ring 286 fitted non-rotationally to the anti-rotation (e.g., hexagonal) fitting 288 of the implant 284. This abutment ring 286 has an exterior side surface 289
10 that mimics the side surface of the transgingival section 120 of the transgingival implant 110 shown in FIGS. 11-12, and a sloping top surface 290 which mimics the sloping outer surface 128 of the transgingival implant 110.

An abutment screw 291 attaches the abutment ring 286 to the implant 284. This screw 291 has a threaded stem 292 which engages the usual threaded bore of the implant
15 284. Above the stem 292, cylindrical and tapered head sections 293 and 294 engage corresponding interior surfaces of the abutment ring 286. The portion of the screw head that projects above the abutment ring 286 is identical to the upper section of the transition component 240 described above. In other words, the head of the screw 291 includes a locator region 295 and an anti-rotation 296 (e.g. hexagonal boss) that are
20 similar to locator zone 252 and anti-rotation zone 250 of the transition component 240. All the other parts shown in FIGS. 17 and 18 are the same as the corresponding parts in FIGS. 15 and 16. Thus, the abutment 260 and the tube 280 can be used with the subgingival implant 284 after it has been fitted with ring 286.

FIGS. 19-25 relate to caps which engage the post of a transgingival implant. In
25 the first embodiment of the invention shown in FIGS. 19-21, a cap 310 has a generally cylindrical-shaped outer sidewall 312 and a tapered inner sidewall 314. This cap 310 has an open bottom 316 bounded by a rim 318 enclosing an annular channel 320. The outer sidewall 310 turns inward at the bottom 311 toward the rim 318. At the top 322 the cap has a dome-shaped top wall 324 with a hole 326 through it. The cap is preferably made
30 of a resilient polymeric material that retains its shape, such as "Delrin."

In a second embodiment of the cap invention shown in FIGS. 22-24, a cap 330 has an open bottom 331 bounded by a rim 333 enclosing an annular channel 335 like the same parts of the cap 310 in FIGS. 19-21. The top 332 of the cap 330 is open and surrounded by an annular rim 334. The inwardly-tapering bottom portion 337 of the 5 sidewall has an upwardly-facing annular shoulder 328 at its upper end. Between this shoulder 328 and the top rim 334 are several additional rims 336, 338 and 340, which decrease progressively in diameter, as shown, from the shoulder 328 to the top rim 334. The shoulder 328 has the largest outer diameter, and the top rim 334 has the smallest 10 outer diameter. A series of generally tubular sidewall sections 342, 344, 346 and 348 are fixed, respectively, between the shoulder 328 and the adjacent rim 336, then rim 336 and rim 338, then rim 338 and rim 340, and finally rim 340 and rim 334. The diameters of these sidewall sections decrease progressively from the shoulder 328 to the top 332 of the cap 330, so that the overall shape of the cap 330 is tapered in diameter from the lower opening 316 to the upper opening 332. Each sidewall section has perforations 349 15 through it.

The caps 310 and 330 of the invention are fitted to the previously-described implants of FIGS. 1-5, 11-12, and 15-18, which will be generically called dental implant 350, by forcing the rims 318 and 333 over the peripheral surface 354 at the bottom of an expanding sloping surface 352 at the top of the implant 350. The annular channels 320 and 335 have a shape complementary to that of the implant 350 so the upper portions of the channels 320 and 335 make contact with the sloping surface 352, while the lower portions of the channels 320 and 335 fit against the upper portion of an inwardly tapering surface 355 directly beneath the rim 354. To enable this lowermost portion of the cap to pass the rim 354 of the implant, the caps are preferably made of a resilient material so 20 that downward pressure urging the lower rims of the cap 310 and 330 against the sloping implant surface 352 cams the rim 318 outwardly, thereby temporarily expanding the diameter of the bottom opening of the cap 330 until the rim 318 clears the implant rim 354. The resilience of the cap 330 then causes the rim 318 to snap back to its original 25 diameter, against the inwardly tapering surface 355 beneath the rim 354. It will be appreciated that this same type of "snap action" may be used to hold the cap in virtually any undercut surface configuration near the top of an implant. As can be seen in FIG. 24,

in its final installed position the cap 330 surrounds a post 356 that is in place on the implant 350.

In an alternative embodiment, the rims 318 and 333 can have a cylindrical internal lower configuration instead of the conical internal configuration. In this 5 embodiment, the rims 318 and 333 of the caps 310 and 330 would engage the implant 350 along the upper sloping surface 352 and the small cylindrical band of the implant (at its widest diameter) just above the inwardly tapering surface 355. This band is usually about 0.004 in to 0.010 inch in height, although it could be made larger. Thus, the rims 318 and 333 of the caps 310 and 330 will have an internal cylindrical section with a 10 similar length to engage the cylindrical band on the implant. Alternatively, the internal cylindrical section may be longer such that it extends below the cylindrical band on the implant 350 but does not engage the inwardly tapering surface 355 of the implant 350.

The cap 310 can be used by itself as a temporary tooth. The clinician applies a cement to the inside surface of the cap 310 and places it on the post. The excess cement 15 then can vacate the cavity under the cap 310 through the hole 326. Because the cap 310 by itself serves as a temporary tooth and is made of relatively inexpensive plastic materials, the invention contemplates producing the cap in various sizes and shapes to generally mimic the outer contours of natural teeth. Thus, the clinician would select the size and shape that would best correspond to the conditions in the patient's mouth. 20 Alternatively, the cap 310 could be modified by the clinician to produce a more esthetically pleasing contour. Furthermore, cap 310 can be simply used without cement for a short time (less than two days for example) to get the patient from the periodontist to the restorative dentist.

Also, the cap 310 can form the gingiva at its bottom 311. While in some 25 instances a clinician will place the implant 350 such that its upper sloping surface 352 is at or above the outer gingival surface, some clinicians may place the implant 350 such that its upper sloping surface 352 is well below the gingival surface. Thus, the cap 310 may engage and form the gingiva for 2 mm to 3 mm above its lowermost surface.

Because the cap 310 will form a ring-shaped cavity in the gingiva adjacent to and 30 around the inwardly tapering surface 355, the cap 310 is useful prior to taking an impression because it is beneficial to slightly move the gingival tissue away from the

implant 350 before the impression process. Thus, the impression material can flow into this ring-shaped cavity to obtain a better impression of the region along the inwardly tapering surface 355 of the implant 350. While this process of displacing the gingival tissue occurs after the cap 310 has been positioned on the implant for some time (e.g. one

5 day to one week), it can be expedited to just a few minutes by dipping the bottom 311 of the cap 310 in gingival retraction chemicals which results in the gingiva tightening and pulling away from the implant 350. Thus, the ring-shaped cavity is created due to the mechanical action of the cap 310 and the chemical action of the gingiva retraction chemical. Furthermore, it is possible to produce the cap 310 or just its bottom 311 from

10 a porous material to enhance the ability of the cap to retain the gingival retraction chemical prior to its release into the gingival tissue.

To achieve a temporary tooth that is cosmetically pleasing and can last for several months, the cap 330 of FIGS. 22-23 should be used, as is illustrated in FIG. 24. An appropriately-shaped shell 360, chosen to mimic the tooth being restored, is filled

15 (wholly or partially as desired) with a quantity of a dental plastic material (e.g., acrylic) that hardens slowly, and the "filled" shell is placed over the cap as is illustrated in FIG. 25, and manipulated to force the plastic material (not shown in FIG. 25) through the perforations 349 into contact with the post 356. The spaces between the shell 360 and the cap 330, and between the cap 330 and the post 356 (not shown in FIG. 25) will be

20 filled with the hardening plastic material. In practice, the clinician preparing the temporary tooth will gently seat and remove the shell 360 and the cap 330 with the hardening material around the post 356 while the plastic material hardens. When the plastic material has hardened, that person will remove this assembly from the post for final preparation of the temporary tooth. If the tooth is being prepared in patient's mouth

25 where the site has one or two adjacent teeth, it may be desired to remove the rim 333 of the cap 330 from the implant 350, at least until preparation of the tooth is completed. If the tooth is being prepared on a model outside the patient's mouth, where the site can be isolated, the rim 333 can be usefully retained, because the final temporary tooth need not extend below the implant rim 354 (and the hardening of the temporary tooth material

30 around the cap 330 may reduce the flexibility of the rim 333). In either case, in the final preparation of the tooth, the shell 360 may be removed and the hardened plastic material

may be shaped and polished, and then cemented in place on the post 356 with a suitable dental cement. It will be appreciated that FIG. 25 is not drawn to scale. In practice, the shell may be closer to the post than this illustration shows it. While no acrylic (or other suitable tooth-forming material) has been illustrated, such materials are well-known in

5 the dental art.

The cap 330 may be adjusted in length to match the length of the post 356 by cutting the cap 330 at the top of any of the intermediate rims 336, 338 or 340. FIG. 24 shows a post 356 which extends to the uppermost rim 334 at the top opening 332. If a shorter post is used, the cap 330 can be shortened to match the post by removing that

10 portion of the cap 330 above the first rim 340 beyond the top of post. Preferably, the rims 336, 338 and 340 would be positioned to correspond to the common sizes in which posts are available.

The invention is not limited to the physical configurations of the implant and the caps that are illustrated herein by way of example. The dental arts include a wide variety

15 of implants and posts and abutments designed for use with them. The invention is intended to apply to all such to which it can be adapted.

CLAIMS:

1. A dental implant for implantation in living jawbone having overlying gingiva, comprising:
 - a generally cylindrical body section having an exterior surface for confronting said jawbone;
 - 5 a head section attached to said body section for extending through said overlying gingiva when said body section is confronting said jawbone, said head section having an end portion which is generally near an outer layer of said gingiva; and
 - a bore within said head section extending to an opening at said end portion of said head section, said bore being defined by first, second, and third walls, said first wall having internal threads, said second wall having a larger diameter than said first surface and being substantially cylindrical, said second wall extending from said first wall toward said end portion, said third wall extending from said second wall to said opening, said third wall flaring toward said opening to a diameter that is wider than a diameter of said second wall.
 - 10 2. The dental implant of claim 1, wherein said second wall is fitted with at least one thread groove separated by lands on said second wall such that said bore has two distinct internally threaded sections.
 3. The dental implant of claim 2, wherein said lands preserve a major portion of said second wall.
 - 15 4. The dental implant of claim 2, wherein said thread grooves form a multi-lead thread.
 5. The dental implant of claim 4, wherein a pitch of said thread grooves is approximately one millimeter.
 6. The dental implant of claim 1, wherein said head section flares outwardly from
 - 20 25 said main body toward said end portion.
 7. The dental implant of claim 6, wherein said exterior surface of said main body section is threaded and said head section has a smooth external surface.
 8. The dental implant of claim 1, wherein said bore extends into said body section.

9. The dental implant of claim 8, wherein said first wall is entirely within said body section.
10. The dental implant of claim 8, wherein said third wall is entirely within said head section.
- 5 11. The dental implant of claim 10, wherein said second wall is entirely within said head section.
12. The dental implant of claim 1, wherein said end portion of said head section includes a generally annular surface that is at an angle with respect to a central axis of said implant, said angle being substantially less than 90°.
- 10 13. The dental implant of claim 12, wherein said end portion further includes a non-round fitting adjacent to said annular surface.
14. The dental implant of claim 12, wherein said angle is approximately 45°.
15. The dental implant of claim 1, wherein said exterior surface of said main body section is roughened and said head section has a smooth external surface.
- 15 16. The dental implant of claim 1, wherein said flaring of said third wall is at angle suitable to provide a locking taper for engagement with a corresponding taper on a mating component.
17. A system for delivering an implant into living bone comprising:
an implant having an exterior surface for confronting said living bone and
- 20 including a bore that has an opening at an end portion of said implant, said bore being at least partially defined by a substantially cylindrical section;
a carrier device having an expandable portion and a non-round fitting, said expandable portion being inserted to said substantially cylindrical section of said bore of said implant, said non-round fitting being accessible near said end portion of said
- 25 implant; and
means for expanding said expandable cylindrical segment into tight engagement with said substantially cylindrical section of said bore.
18. The implant delivery system of claim 17, wherein said bore further includes a threaded section positioned below said cylindrical segment.
- 30 19. The implant delivery system of claim 18, wherein said bore further includes a flared section positioned above said cylindrical section.

20. The implant delivery system of claim 17, wherein said substantially cylindrical section has an uninterrupted circular cross-section.
21. The implant delivery system of claim 17, wherein said expandable portion includes a plurality of fingers having radial extremities which reside on a generally circular locus.
5
22. The implant delivery system of claim 21, wherein a diameter of said generally circular locus is slightly less than a diameter of said substantially cylindrical section prior to the actuation of said expanding means.
23. The implant delivery system of claim 17, wherein said carrier has a hollow section within said expandable portion, said expanding means includes a structure inserted into said hollow section.
10
24. The implant delivery system of claim 23, wherein said hollow section includes internal threads and said structure has outer threads for threadably engaging said internal threads of said hollow structure.
- 15 25. The implant delivery system of claim 24, wherein said hollow section includes wedge blocks for engaging an end of said structure.
26. The implant delivery system of claim 17, wherein said carrier includes a radially extending flange between said non-round fitting and said expandable portion for engaging said end portion of said implant.
- 20 27. The implant delivery system of claim 26, wherein said end portion includes a generally annular surface that is at an angle with respect to a central axis of said implant, said angle being less substantially less than 90°, said radially extending flange has a surface cooperating with said generally annular surface.
28. The implant delivery system of claim 17, wherein said generally cylindrical wall
25 includes thread grooves separated by lands on said generally cylindrical wall.
29. The implant delivery system of claim 28, wherein said expandable portion has threads which mate with said thread grooves.
30. The implant delivery system of claim 28, wherein said bore has a second threaded section of a different diameter than said first threaded region for engaging fasteners
30 holding artificial dentition on said implant.
31. A system for delivering an implant into living bone comprising:

an implant having an exterior surface for confronting said living bone and including a bore that has an opening at an end portion of said implant, said bore being at least partially defined by a threaded section;

5 a carrier device having an expandable threaded portion and a non-round fitting, said expandable threaded portion being threadably inserted into said threaded section of said bore of said implant, said non-round fitting being accessible near said end portion of said implant; and

means for expanding said expandable threaded segment into tight engagement with said threaded section of said bore.

10 32. The implant delivery system of claim 31, wherein said threaded section is formed by multi-lead threads.

33. The implant delivery system of claim 32, wherein a pitch of said threaded section is approximately one millimeter.

34. The implant delivery system of claim 31, wherein a torque required to threadably 15 insert said expandable threaded portion into said threaded section of said bore is less about 10 N-cm prior to actuation of said expanding means.

35. The implant delivery system of claim 31, wherein said non-round fitting is capable of receiving about 40 N-cm of torque while said implant is held non-rotationally without significant movement of said expandable threaded portion relative to said 20 threaded section due to said tight engagement of said expanding means.

36. The implant delivery system of claim 35, wherein said non-round fitting is capable of receiving 100 N-cm of torque while said implant is held non-rotationally without significant movement of said expandable threaded portion relative to said threaded section due to said tight engagement.

25 37. The implant delivery system of claim 31, wherein said expandable threaded portion is fully inserted into said threaded section in approximately one turn.

38. The implant delivery system of claim 31, wherein said carrier has a hollow section within said expandable portion, said expanding means includes a structure inserted into said hollow section.

39. The implant delivery system of claim 38, wherein said hollow section includes internal threads and said structure has outer threads for threadably engaging said internal threads of said hollow structure.

40. A restoration system for fixing artificial dentition to edentulous living jawbone,
5 comprising:

an implant including a body section with an exterior surface for confronting said jawbone and a head section attached to said body section for extending through said overlying gingiva when said main body section is confronting said jawbone, said head section having an end portion which is generally near an outer layer of said gingiva, said
10 implant further having a bore within said head section extending to an opening at said end portion of said head section, said bore being defined by first, second, and third walls, said first wall having internal threads, said second wall having a larger diameter than said first surface and being substantially cylindrical, said second wall extending from said first wall toward said end surface, said third wall extending from said second wall to said
15 opening, said third wall flaring outwardly at an angle toward said opening; and

a post including a first externally-threaded post section for engagement within said internally-threaded first wall of said bore, a second post section of larger diameter than said first post section to fit within said second wall of said bore, and a third post section for engagement with said third wall of said bore, said third post section flaring on
20 substantially the same angle as said third wall for locking engagement with said third wall.

41. The restoration system of claim 40, wherein said post further has, adjacent to said third post section, a support section for receiving said artificial dentition, said support section having a transverse dimension adjacent to said third post section which is
25 generally the same size as a diameter of said bore at said opening.

42. The restoration system of claim 40, wherein said support section has a remote end positioned distally from said third post section, said support section tapering to a smaller transverse dimension at said remote end.

43. The restoration system of claim 40, further including a lubricant between said
30 third post section and said third wall.

44. The restoration system of claim 43, wherein said lubricant is solid lubricant.

45. The restoration system of claim 44, wherein said solid lubricant is a plating on said third post section.

46. A restoration system for fixing artificial dentition to edentulous living jawbone, comprising:

5 a dental implant having a body for confronting said jawbone and a head section terminating in an end portion accessible outside said jawbone, said implant having a bore with an opening at said end portion, said end portion including a generally annular surface and non-rotational engagement means outside of said bore and adjacent to said annular surface, said non-rotational engagement means is capable of interlocking with

10 complementary engagement means of said artificial dentition; and

15 a post for supporting said dentition, said post having a first part extending into said bore for axially retaining said post to said implant and a second part extending beyond said end portion of said implant on which said artificial dentition is mounted, said second part having a transverse dimension adjacent to said opening that is smaller than a transverse dimension of said end portion such that said non-rotational engagement means is exposed when said post is fixed to said implant.

15 47. The restoration system of claim 46, wherein said non-rotational engagement means is a boss of non-round cross-section.

48. The restoration system of claim 47, wherein said boss has "n" sides and the cross-

20 sectional shape of said complementary engagement is adapted to provide at least "2n" fixed orientation positions of said artificial dentition around said post.

49. The restoration system of claim 48, wherein said boss has a hexagonal cross-sectional shape.

50. The restoration system of claim 47, wherein said boss is directly adjacent to said

25 annular surface.

51. The restoration system of claim 47, wherein said annular surface is at approximately 90° with respect to a central axis of said implant.

52. A transition component for converting a dental implant lacking a non-round fitting at its uppermost surface into a modified dental implant having an external non-round

30 boss, said dental implant having bore that extends to an opening in an end portion, said bore being defined by first, second, and third walls, said first wall having internal

threads, said second wall having a larger diameter than said first surface and being substantially cylindrical, said second wall extending from said first wall toward said end portion, said third wall extending from said second wall to said opening, said third wall flaring toward said opening to a diameter that is wider than a diameter of said second wall, said transition component comprising:

- a lower threaded segment for engaging said internally threaded first wall;
- a tapering segment for engaging said third wall, said tapering segment tightly engaging said third wall in response to said lower threaded segment being fully threaded into said first wall; and

10 a protruding non-round fitting being positioned above said end portion of said dental implant.

53. The transition component of claim 52, further including a registering section above said protruding non-round fitting for ensuring alignment of a mating component on said protruding non-round fitting.

15 54. The transition component of claim 52, wherein said tapering segment and said third wall provide a locking taper.

55. The transition component of claim 52, wherein said tapering section includes a lubricant.

56. The transition component of claim 52, wherein said end portion of said implant

20 includes a generally annular surface at an angle with a central axis of said implant that is substantially less than 90°, said protruding section being directly below said annular surface.

57. The transition component of claim 52, wherein said second wall is substantially cylindrical and said transition component includes a generally cylindrical portion

25 between said threaded segment and said tapering segment, said generally cylindrical portion of said transition component and said second wall of said implant being substantially the same diameter.

58. The transition component of claim 57, wherein said second wall and said generally cylindrical portion provide an alignment of said transition component on said

30 implant.

59. The transition component of claim 52, further in combination with an abutment for supporting an artificial tooth, said abutment including a skirt portion which rests on said end portion of said implant and a non-round socket for receiving said protruding non-round fitting, and means for axially retaining said skirt portion on said end portion.

5 60. The combination of claim 59, wherein said transition component includes an internally threaded hole and said retaining means is a screw that is threaded into said internally threaded hole.

10 61. The combination of claim 59, wherein said transition component and said abutment include means for registering said transition component relative to said abutment.

62. A set of transition components for converting a generally-cylindrical, subgingival type of dental implant having a non-round fitting at its uppermost surface into a single-stage dental implant having a body section for confronting said bone and a head section attached to said body section for extending through said overlying gingiva, said head section flaring outwardly and including an end portion with an annular surface at predetermined angle with respect to a central axis of said single stage implant, said set comprising:

15 a tubular transition component with a non-round socket to mate with said non-round fitting of said subgingival implant, said transition component having an exterior surface that flares outwardly in substantially the same size and shape as head section of said single-stage implant; and

20 means for axially retaining said tubular transition component on said implant.

63. The transition components of claim 62, wherein said predetermined angle is substantially less than 90°.

25 64. The transition components of claim 62, wherein said predetermined angle is about 45°.

65. The transition components of claim 62, wherein said exterior surface flares outwardly from a lowermost end to a maximum diameter forming a first conical surface and then flares inwardly to a smaller diameter near an uppermost end to form a second

30 conical surface.

66. The transition components of claim 65, wherein said annular surface is along said second conical surface.

67. A set of components for making a subgingival dental implant and a transgingival dental implant adapted for use with the same restoration component for supporting a

5 dental prosthesis, said subgingival dental implant having a generally cylindrical body and a non-round fitting at an uppermost surface of said body, said transgingival dental implant having a body section for confronting said bone and a head section attached to said body section for extending through gingiva overlying said bone and flaring outwardly away from said body section, said transgingival type of implant having an

10 internal bore extending into said head section, said set comprising:

15 a tubular component with a socket to mate with said non-round fitting of said subgingival implant, said tubular component having an exterior surface that flares outwardly in substantially the same size and shape as head section of said transgingival implant;

20 a fastener for axially retaining said tubular component on said subgingival implant, said fastener including a first projection protruding above said tubular transition component; and

25 a transition component for insertion into said internal bore of said transgingival type of implant, said transition component including a second projection for extending above said head section,

30 and wherein said first and second segments have substantially the same contour for mating with said restoration component.

68. The conversion set of claim 67 wherein said head section of said transgingival implant includes an end portion with an annular surface at predetermined angle with respect to a central axis of said single stage implant, said tubular component having a similar annular surface.

69. The conversion set of claim 68 wherein said annular surface of said transgingival implant and said annular surface of said tubular component are capable of engaging said restoration component.

35 70. The conversion set of claim 67 wherein said first and second projections each includes a non-round fitting for non-rotationally engaging said restoration component.

71. The conversion set of claim 70 wherein said first and second projections each includes an alignment region for registering said restoration component thereon.

72. The conversion set of claim 67, wherein said bore of said transgingival implant terminates at an opening at an upper portion of said head section and is defined by first, 5 second, and third walls, said first wall having internal threads, said second wall having a larger diameter than said first surface and being substantially cylindrical, said second wall extending from said first wall toward said end portion of said head section, said third wall extending from said second wall to said opening, said third wall flaring toward said opening to a diameter that is wider than a diameter of said second wall.

10 73. The conversion set of claim 72, wherein said transition component includes a threaded stem for mating with said internal threads of said first wall.

74. The conversion set of claim 72, wherein said transition component has a guiding section for mating with and fitting within said second wall.

75. The conversion set of claim 72, wherein said transition component has a tapered 15 wall for mating with said third wall.

76. The conversion set of claim 75, wherein said tapered wall and said third wall form a locking taper.

77. A temporary gingival forming component for a single stage implant having a body for confronting said jawbone and a head section terminating in an end portion at or 20 below overlying gingiva, said head section flares outwardly away from said body to its maximum diameter near said end portion and said end portion includes an annular surface which is at an angle substantially less than 90° with respect to a central axis of said implant, said implant receiving a post for supporting artificial dentition that extends beyond said head section of said implant, said temporary gingival forming component 25 comprising:

a hollow body section for fitting over said post; and

a lower section attached to hollow body section, said lower section having a first internal surface for engaging said annular surface and a second internal surface for contacting said head section at said maximum diameter, said lower section having a 30 smooth rounded exterior surface extending upwardly from a lowermost extremity for engaging and forming said overlying gingiva.

78. The temporary component of claim 77, wherein said lower section of said gingival forming component further includes a third internal surface extending below second internal surface.

79. The temporary component of claim 78, wherein said third internal surface engages 5 said head section below said maximum diameter.

80. The temporary component of claim 77, wherein said lower section is capable of receiving a gingival forming chemical.

81. The temporary component of claim 77, wherein said hollow body section is separated from an exterior surface of said post by a gap, said hollow body section being 10 adapted to receive a cement within said gap to attach said gingival forming component to said post.

82. A temporary support post for a single stage implant having a body for confronting said jawbone and a head section terminating in an end portion at or below overlying gingiva, said head section flares outwardly away from said body to its maximum 15 diameter near said end portion and said end portion includes an annular surface which is at an angle substantially less than 90° with respect to a central axis of said implant, said implant receiving a post for supporting artificial dentition that extends beyond said head section of said implant, said temporary post for supporting a temporary dentition comprising:

20 a hollow body section for fitting over said post and including a plurality of perforations, said hollow body section being separated from said post by a gap, said gap being accessible through said plurality of perforations and receiving material that forms said temporary dentition; and

25 a lower section attached to said hollow body section, said lower section having a first internal surface for engaging said annular surface and a second internal surface for contacting said head section at said maximum diameter.

83. The temporary component of claim 82, wherein said lower section of said temporary post further includes a third internal surface extending below second internal surface.

84. The temporary component of claim 83, wherein said third internal surface engages 30 said head section below said maximum diameter.

31

85. The temporary component of claim 82, wherein said hollow body section includes circumferential ribs extending along an outer surface thereof.

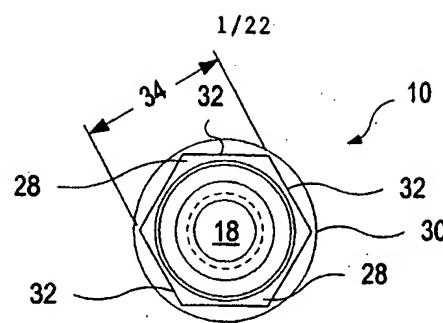


FIG. 1c

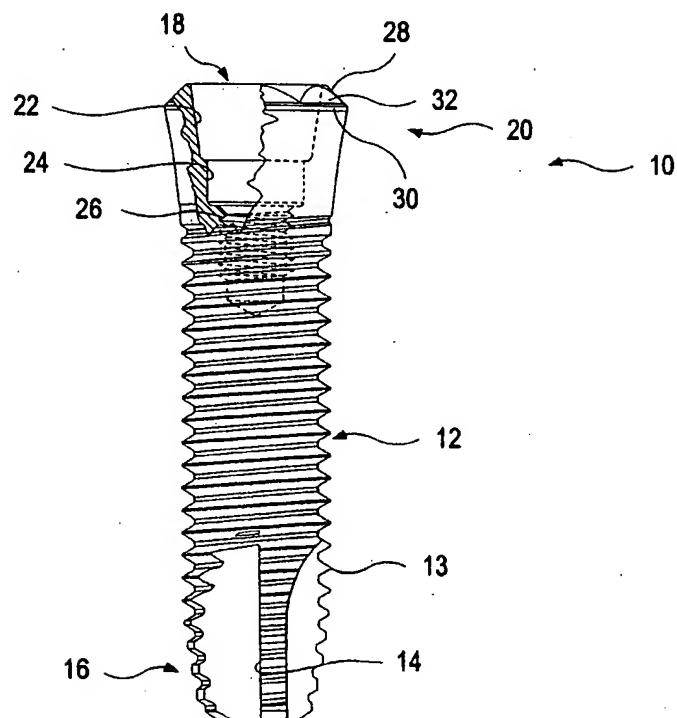


FIG. 1a

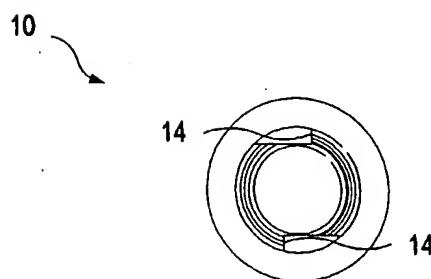


FIG. 1b

2/22

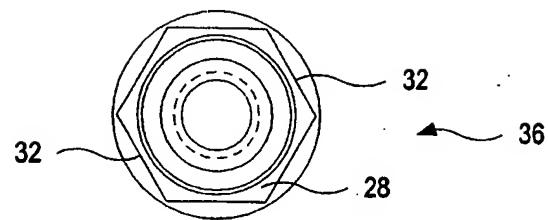


FIG. 2c

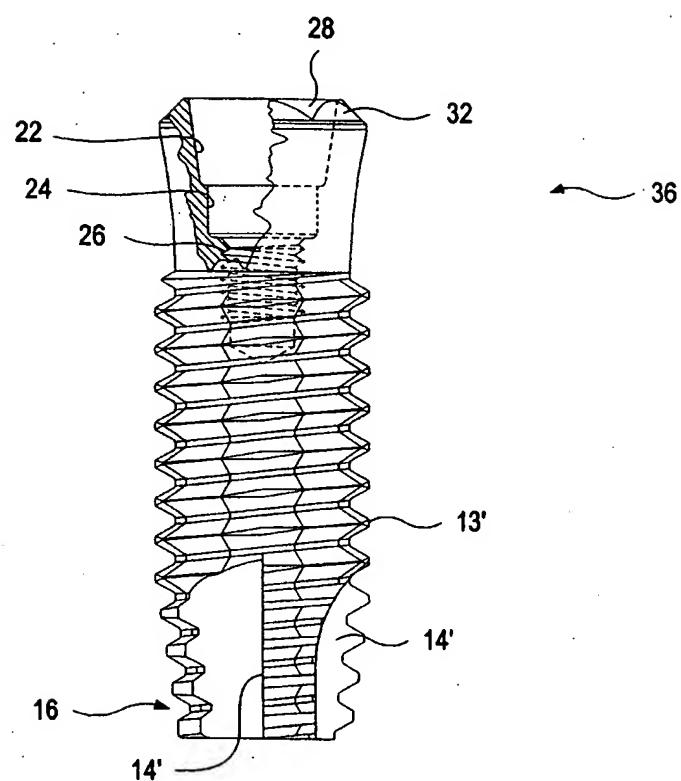


FIG. 2a

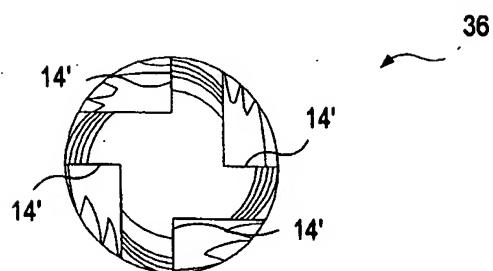


FIG. 2b

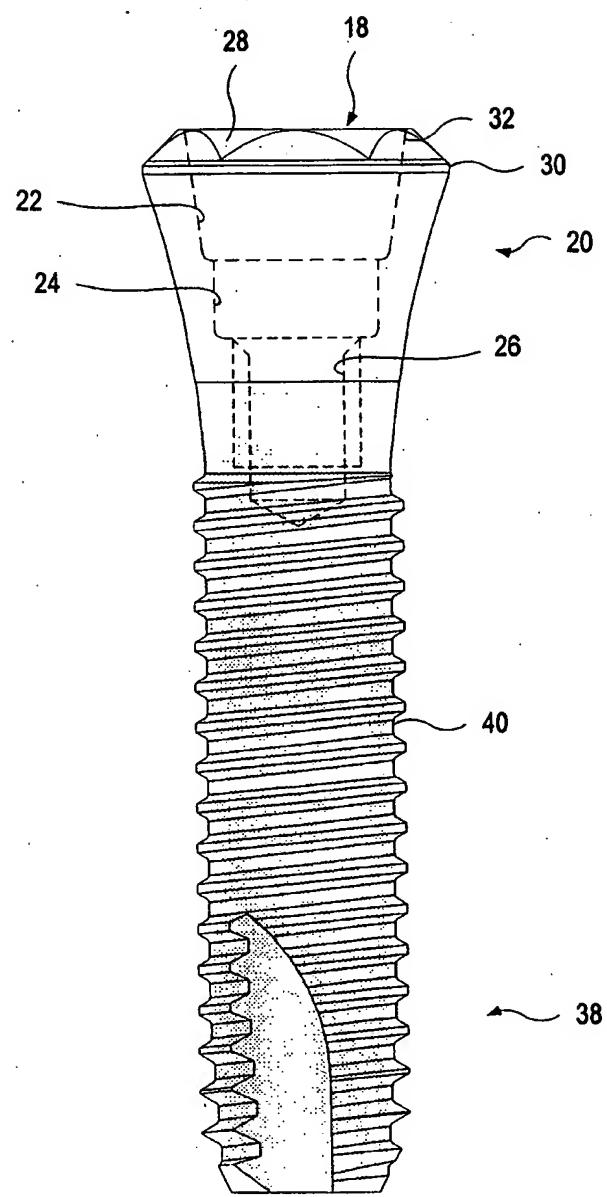


FIG. 3

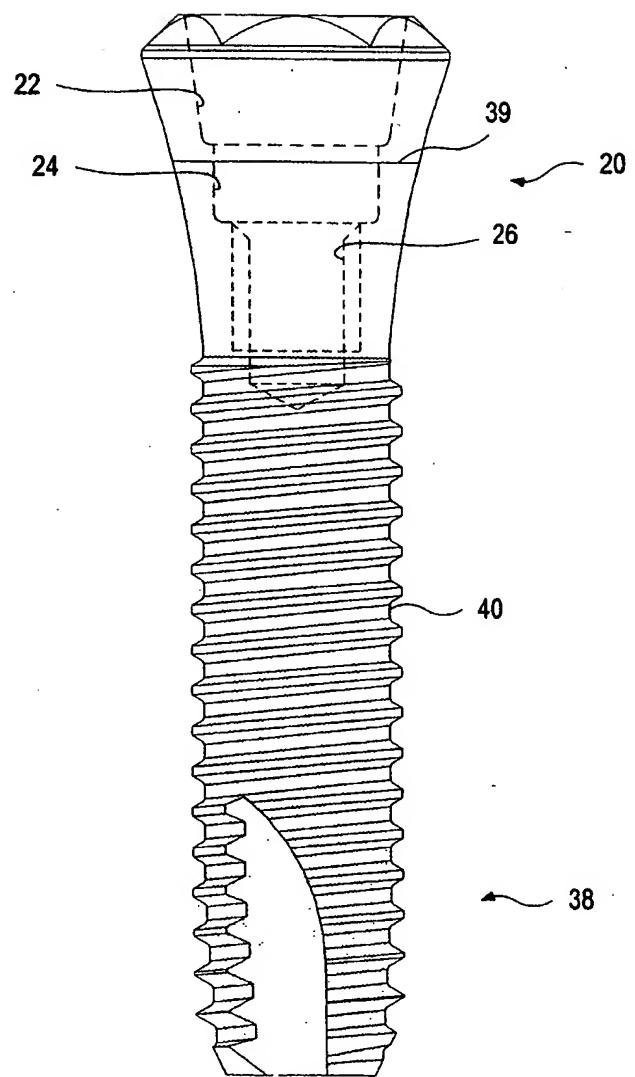


FIG. 4

5/22

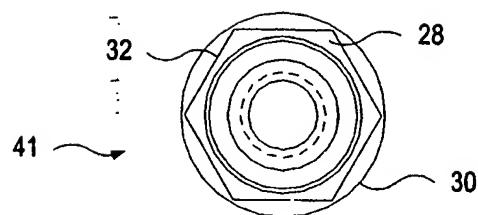


FIG. 5c

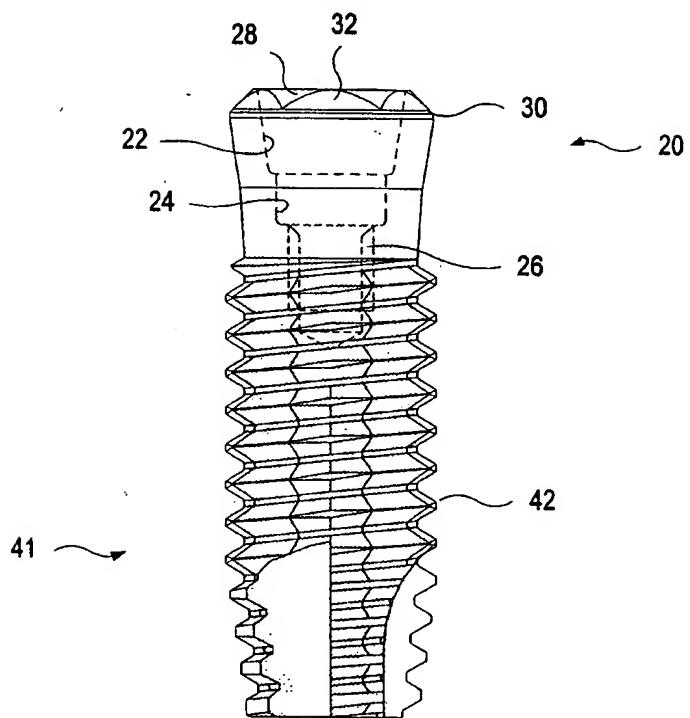


FIG. 5a

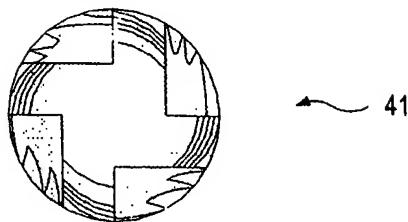


FIG. 5b

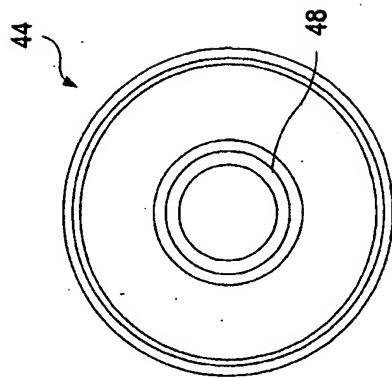


FIG. 6d

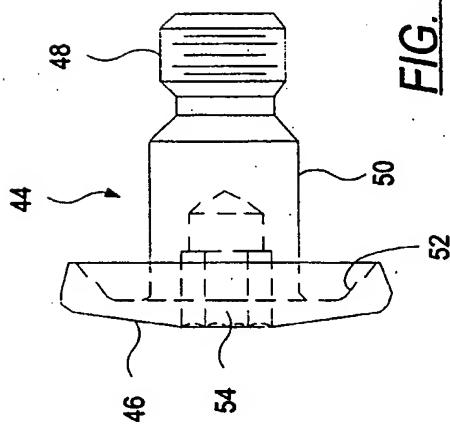


FIG. 6a

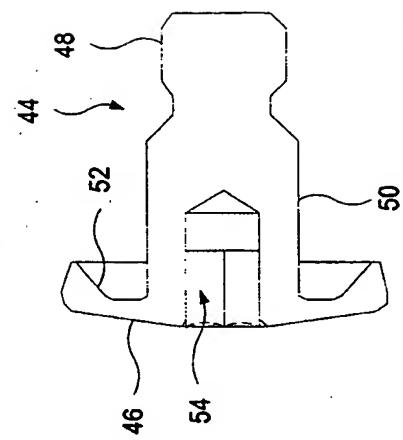


FIG. 6b

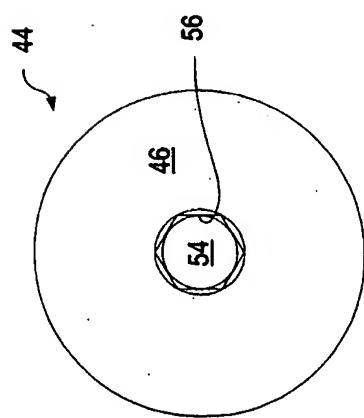


FIG. 6c

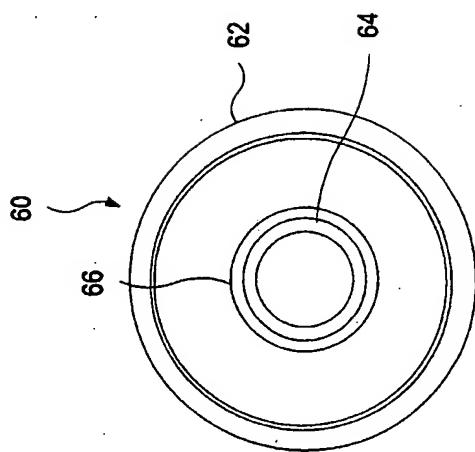


FIG. 7d

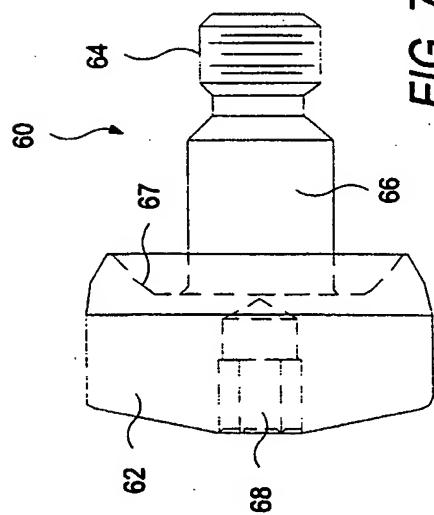


FIG. 7a

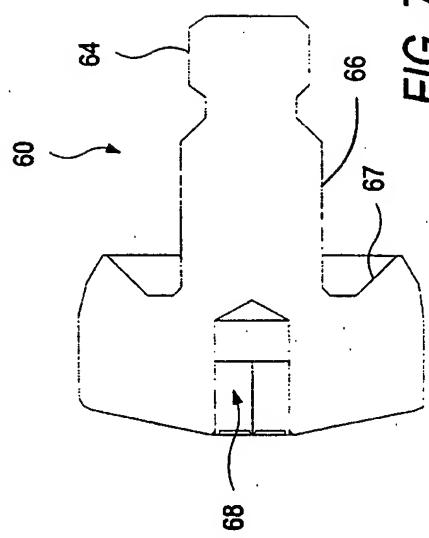


FIG. 7b

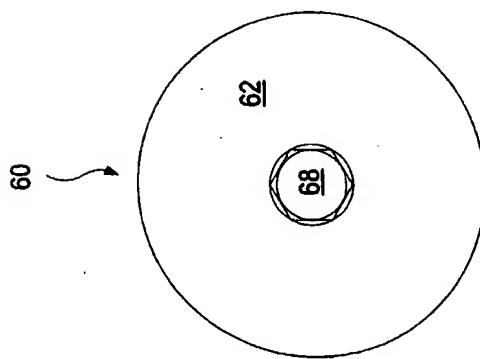


FIG. 7c

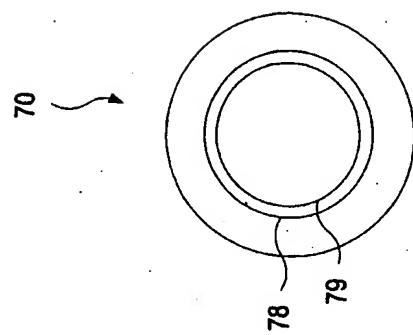


FIG. 8c

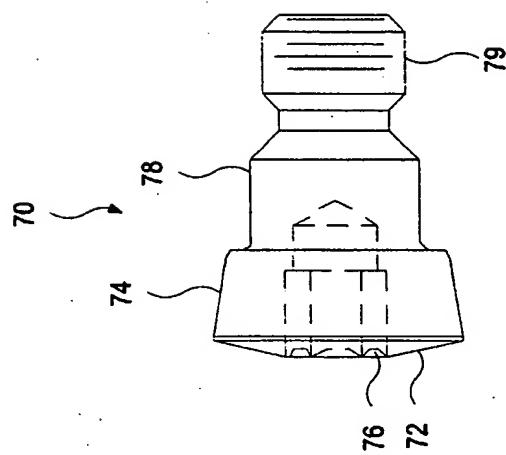


FIG. 8a

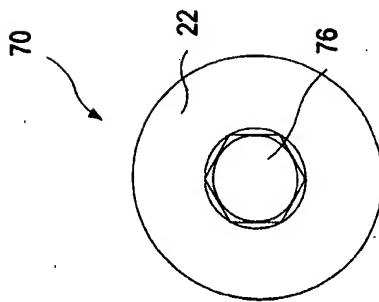


FIG. 8b

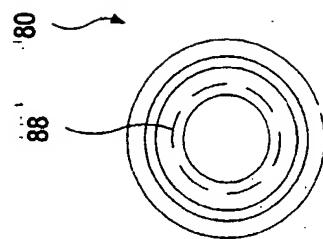


FIG. 9c

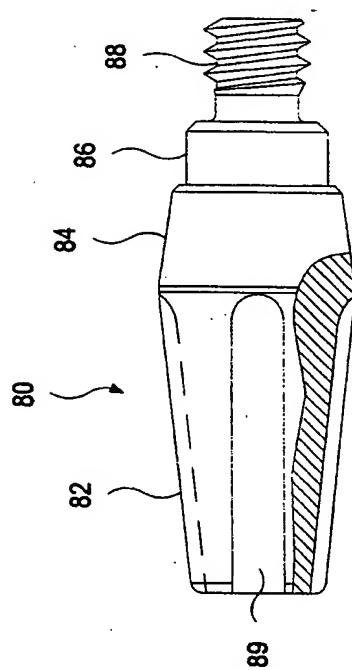


FIG. 9a

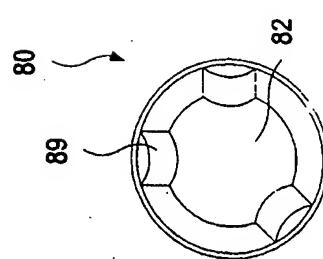


FIG. 9b

10/22

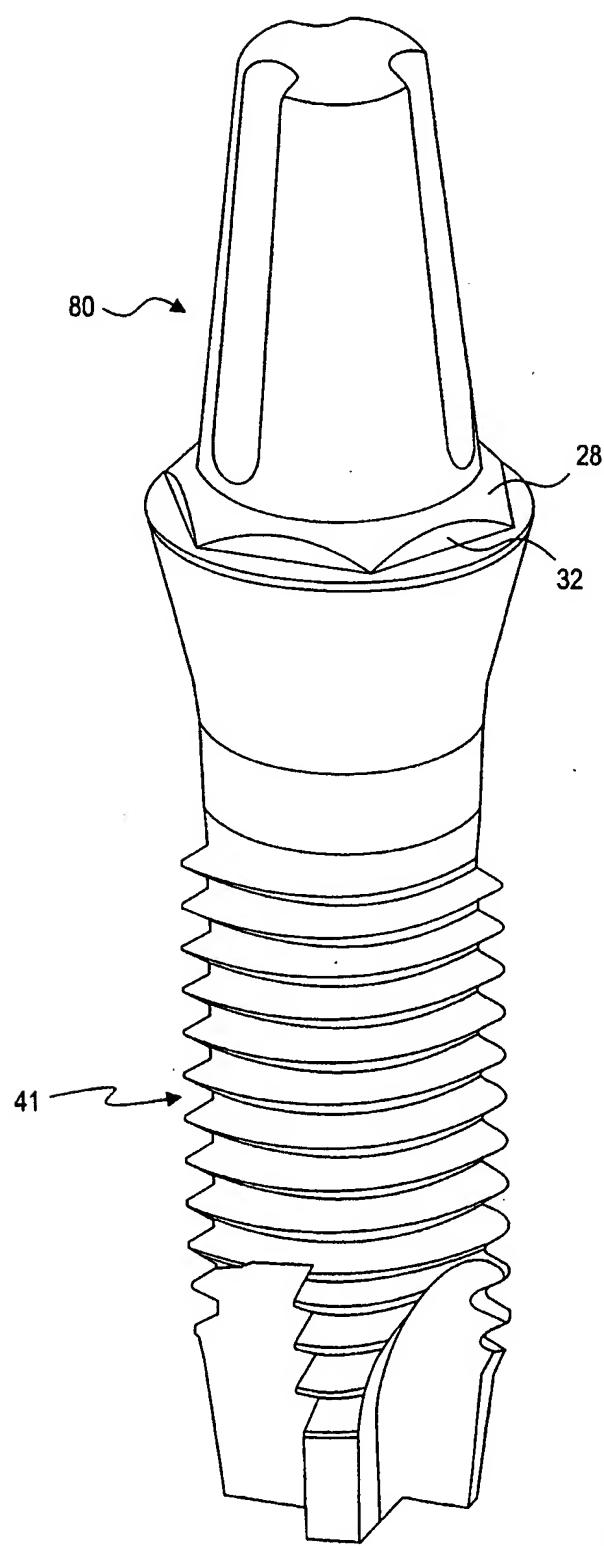


FIG. 9d

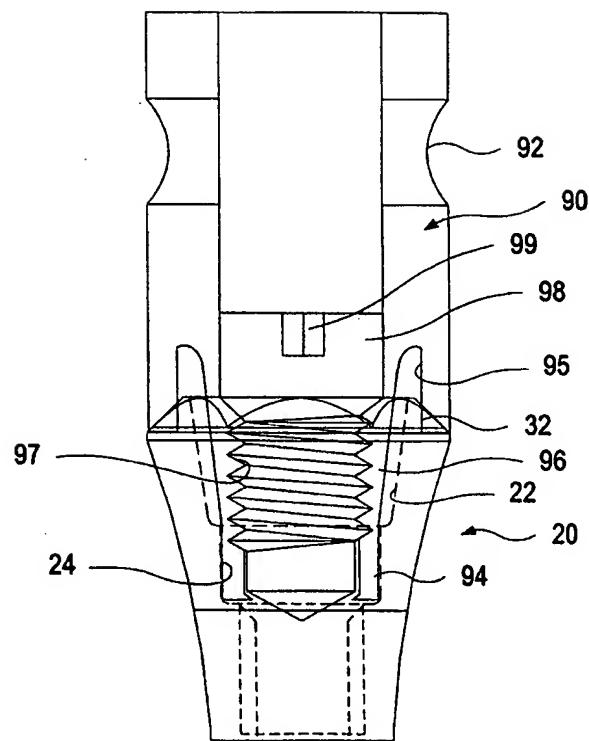


FIG. 10

12/22

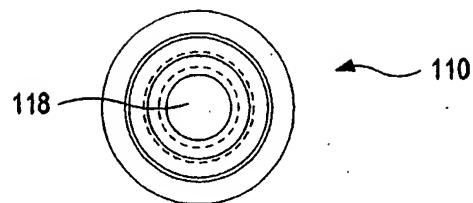


FIG. 11c

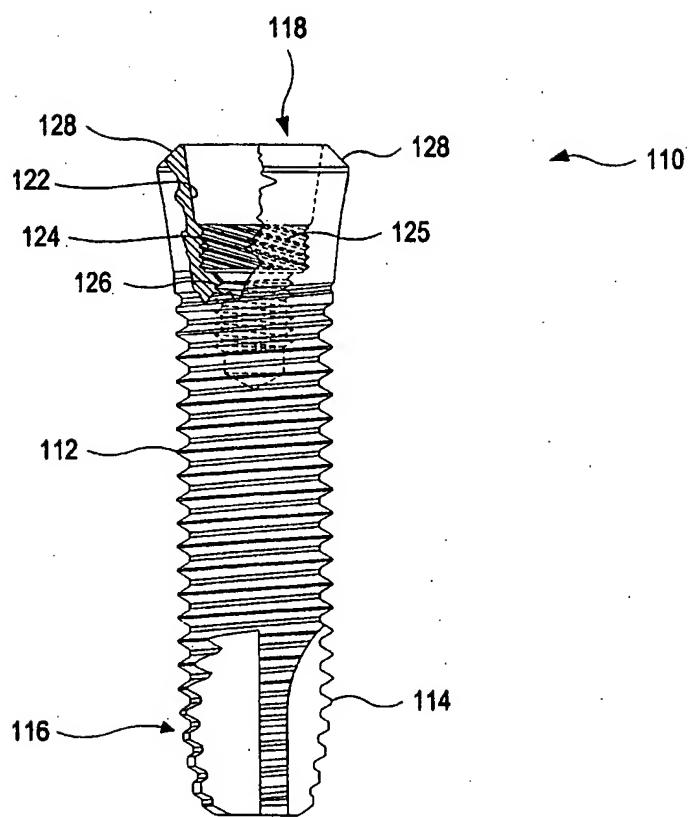


FIG. 11a

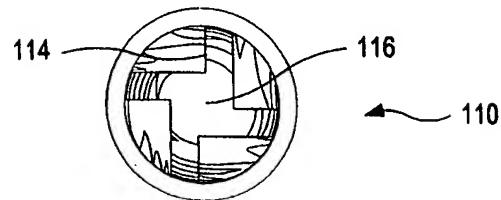


FIG. 11b

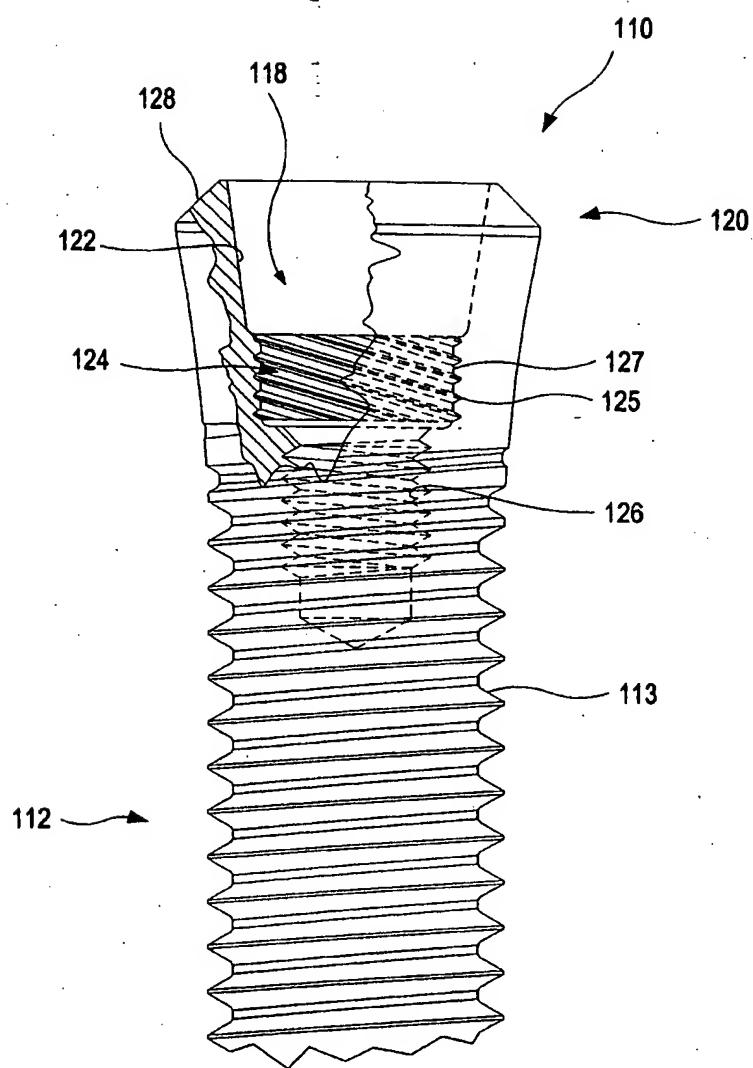


FIG. 12

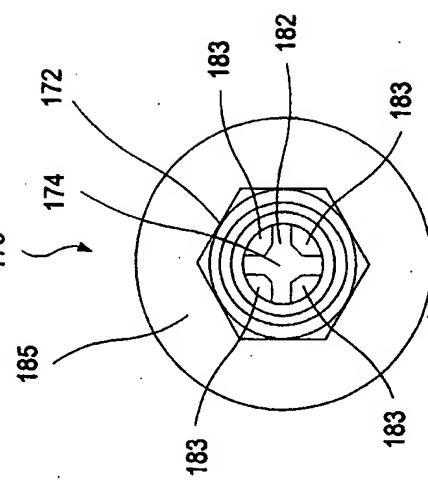


FIG. 13c

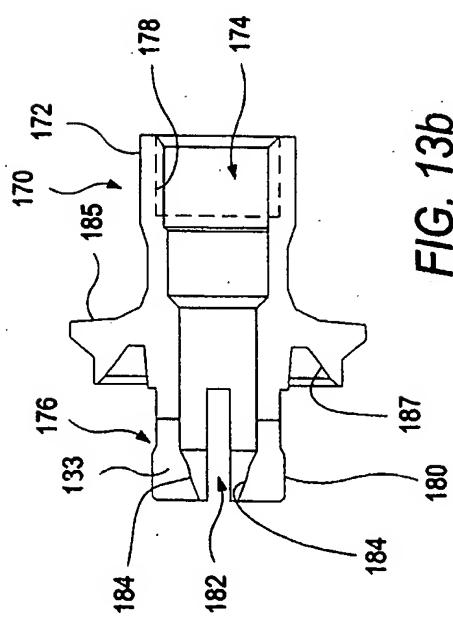


FIG. 13b

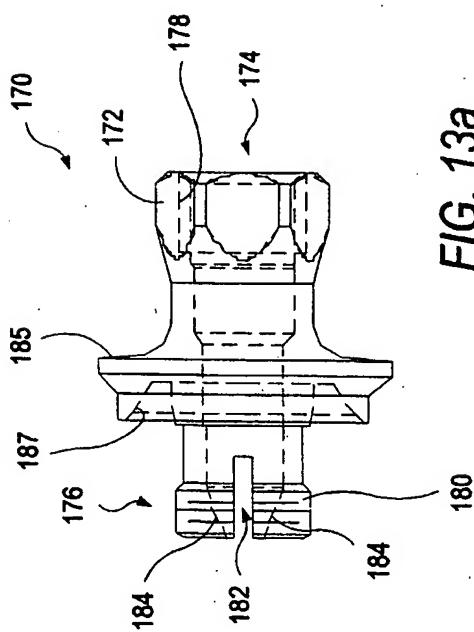


FIG. 13a

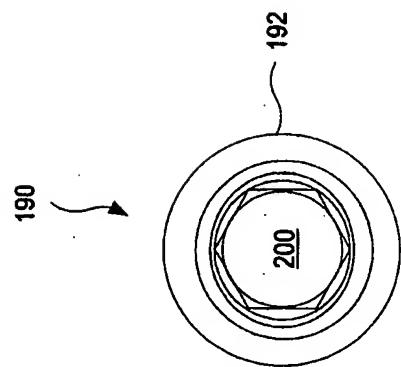


FIG. 14b

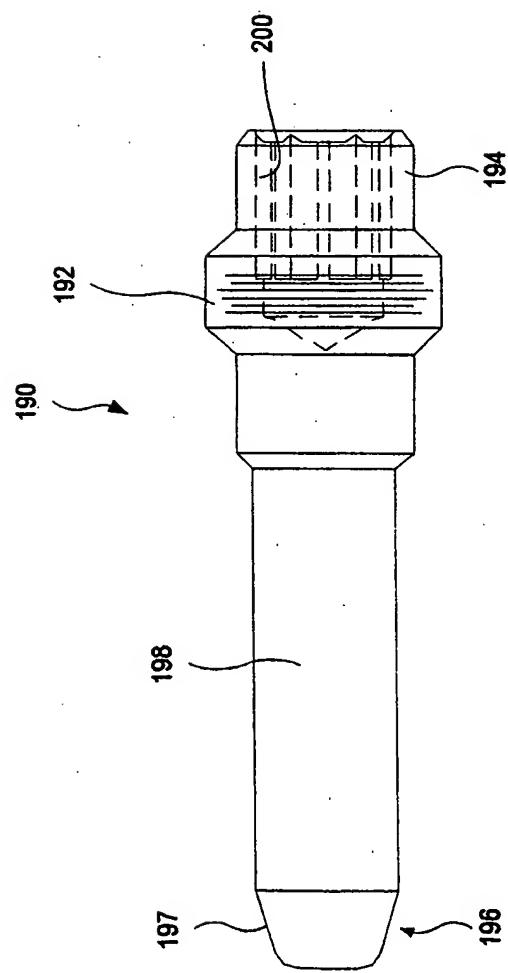


FIG. 14a

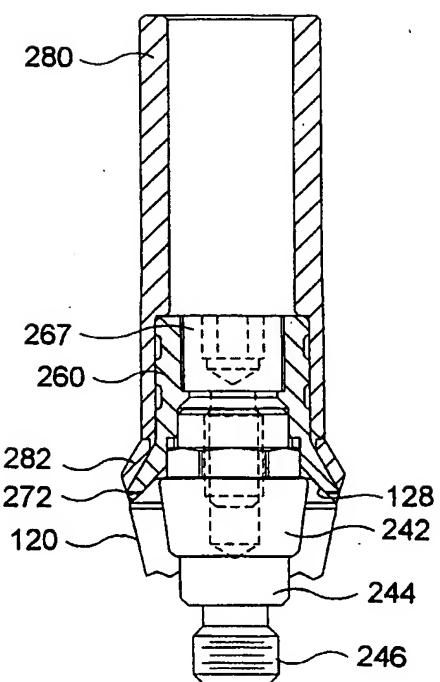
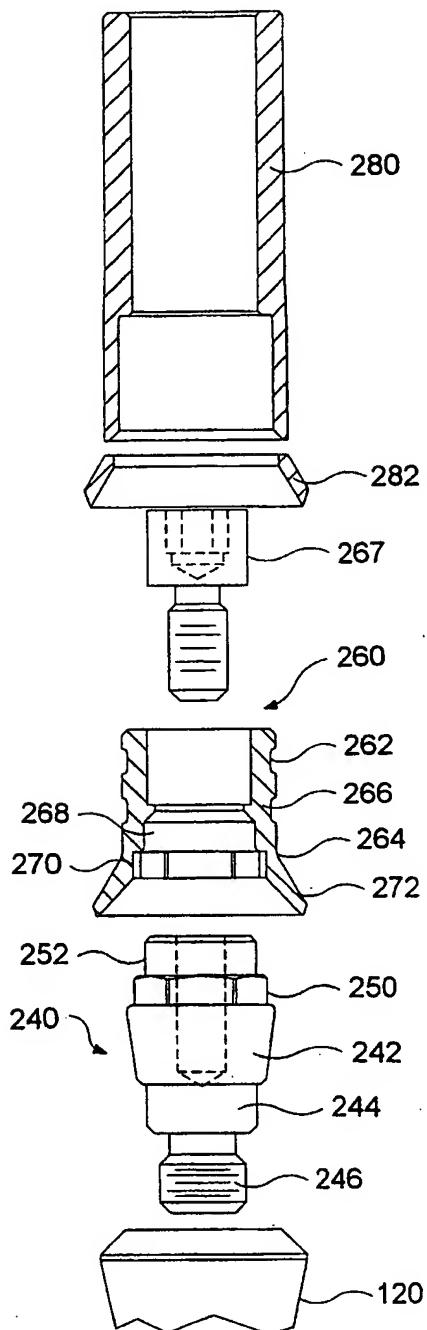


Fig. 15

Fig. 16

17/22

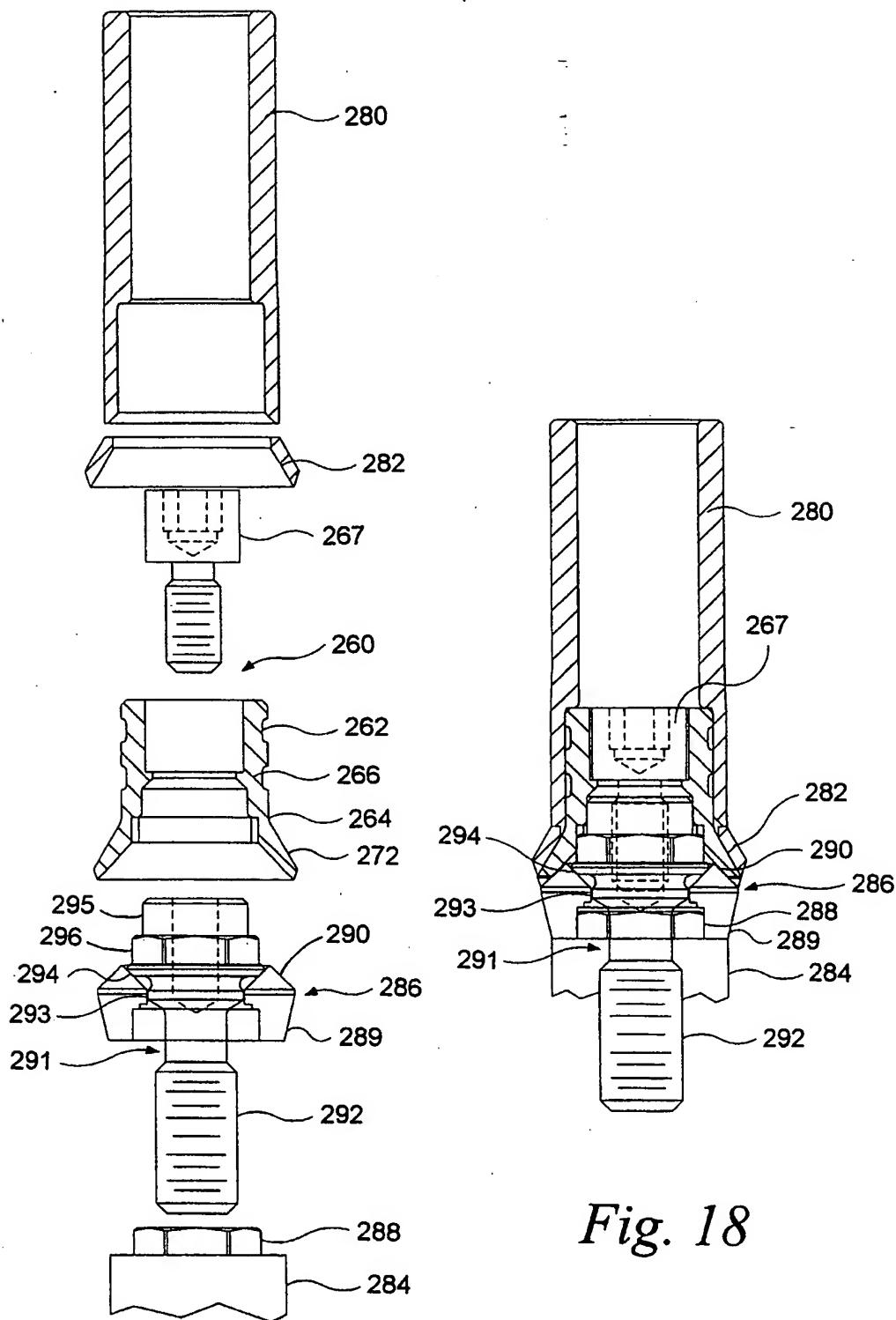


Fig. 18

Fig. 17

Fig. 19

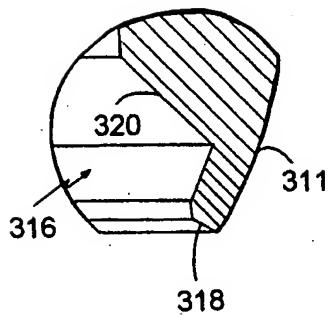
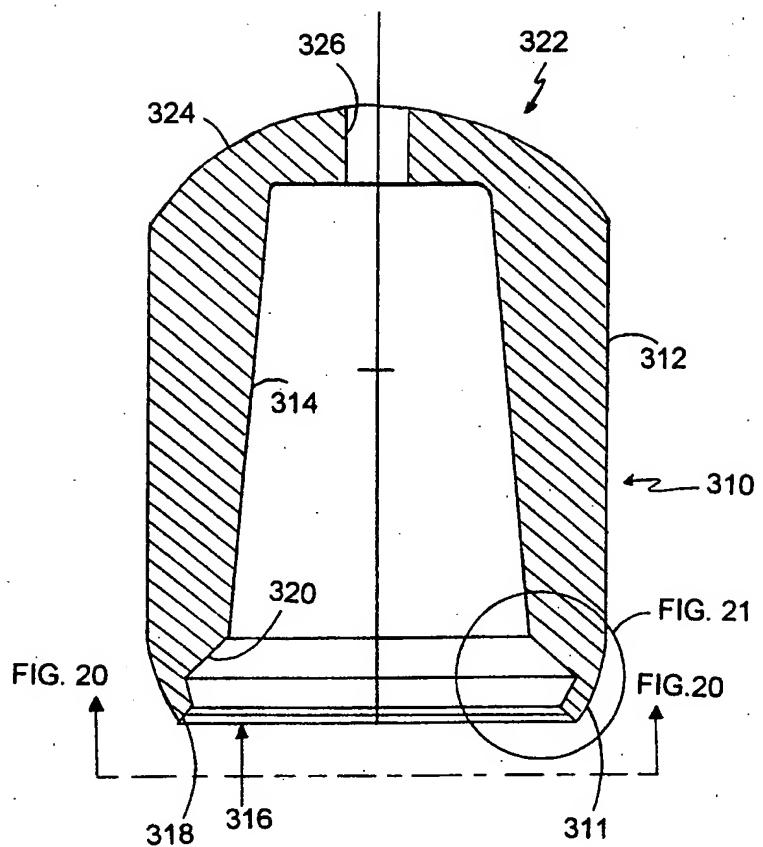


Fig. 21

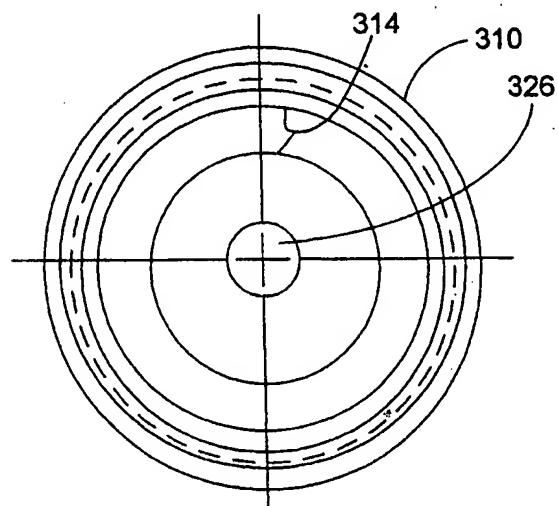


Fig. 20

19/22

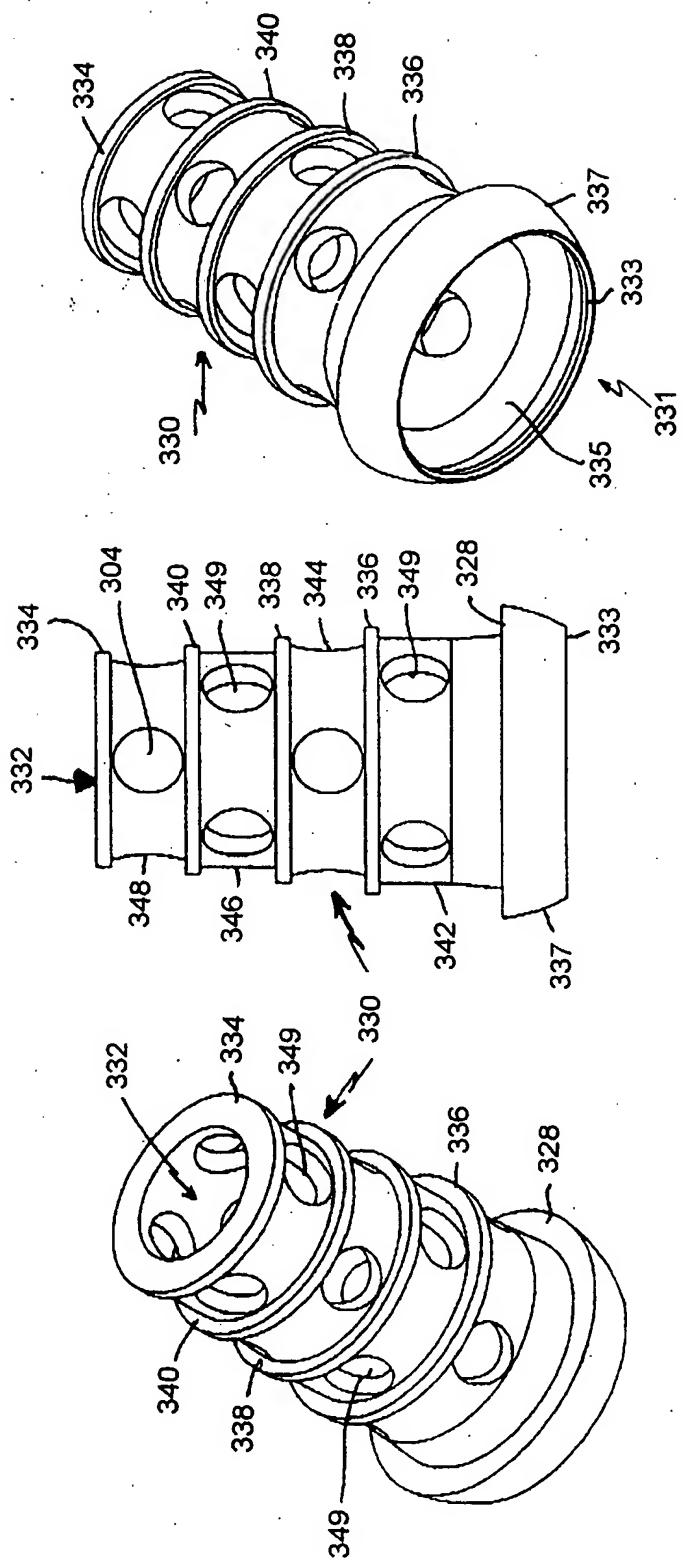


Fig. 22b

Fig. 22c

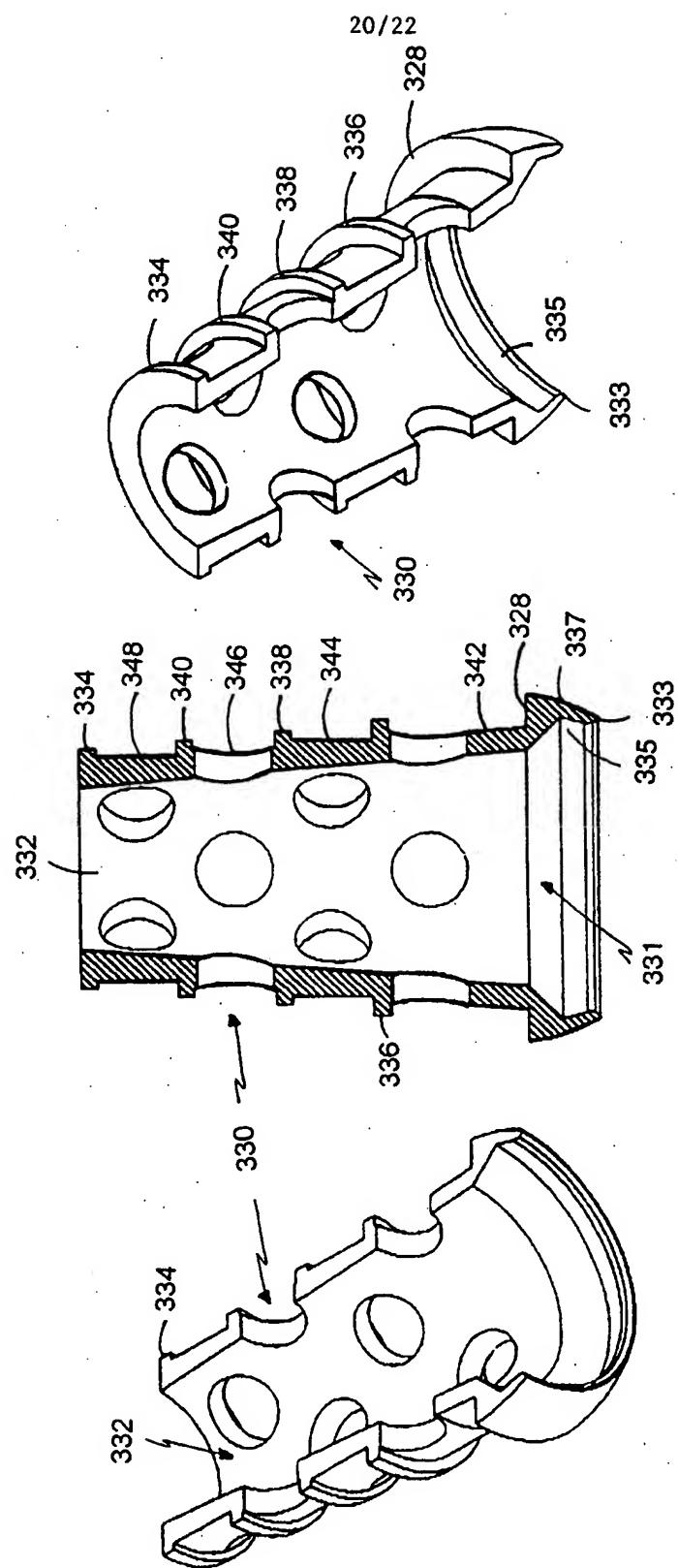


Fig. 23c

Fig. 23a

Fig. 23b

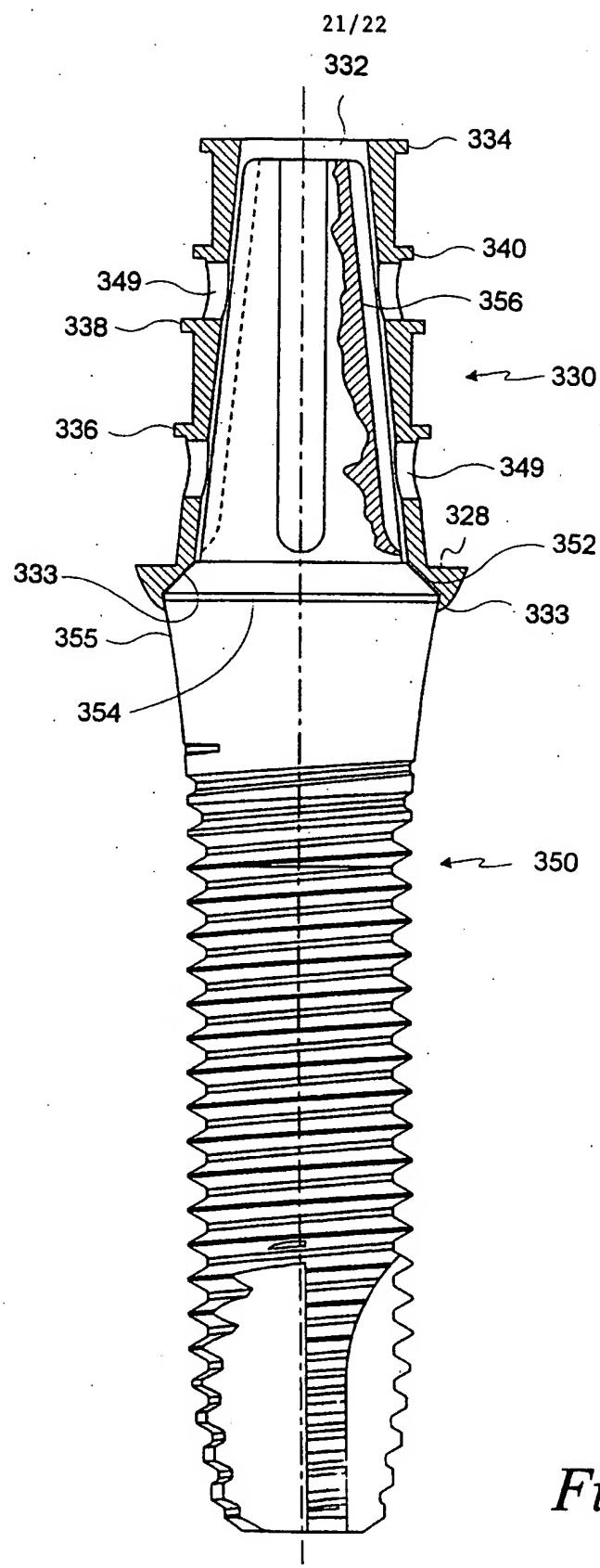


Fig. 24

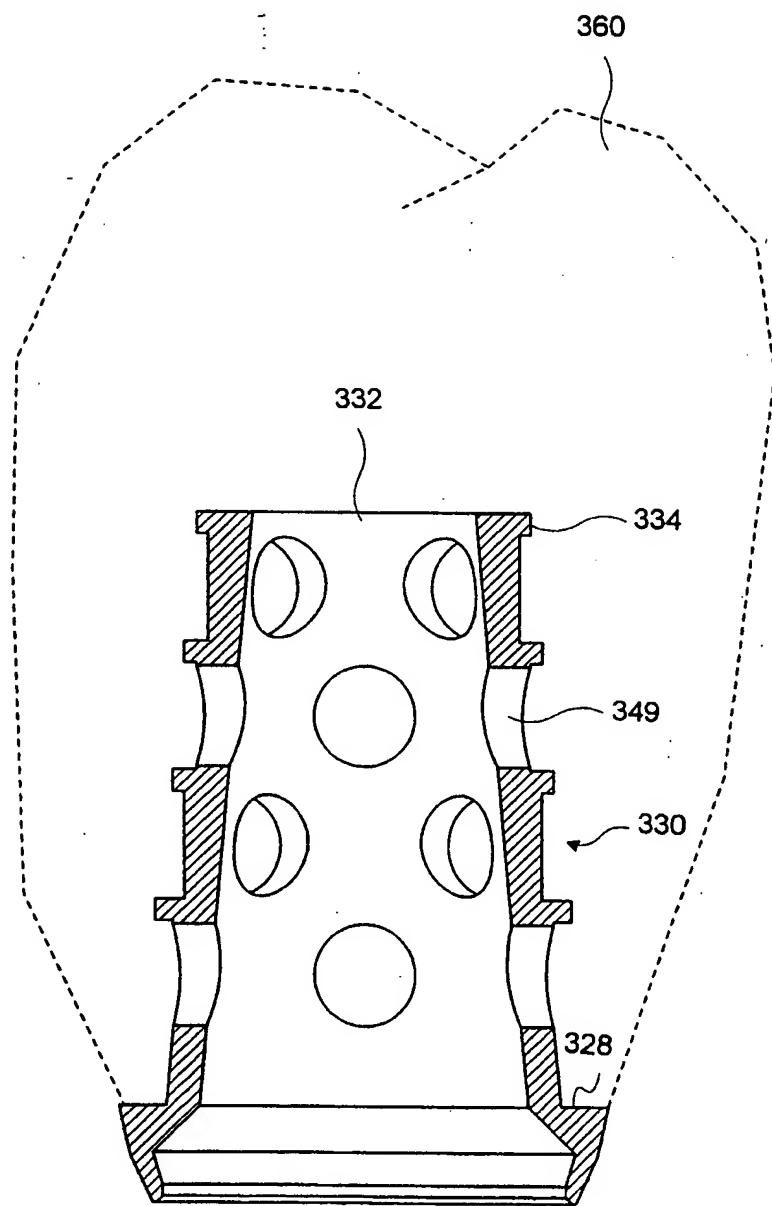


Fig. 25